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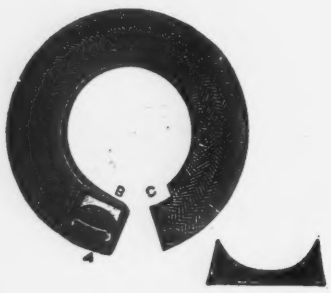

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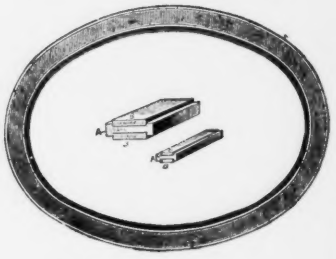

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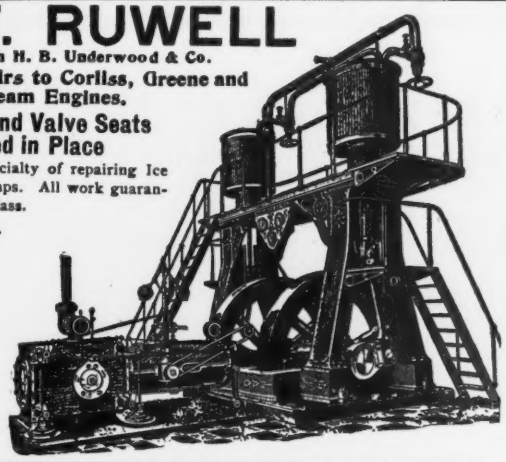

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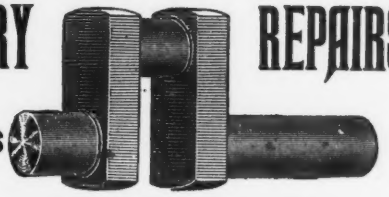

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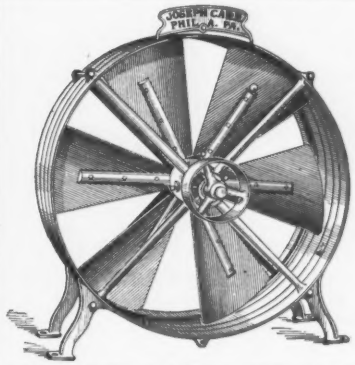

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HEATING SURFACE EFFICIENCY.

BY R. T. STROHM.

Not a great while ago, in the columns of this Journal there appeared the statement that an increase of heating surface would lead to an increase in the evaporation capacity. Generally speaking, this is true, but it is not of universal application. As a matter of fact, it is true only within ordinary limits. It is possible to increase the amount of heating surface beyond a point where, instead of increasing the duty, it actually lessens the boiler capacity.

The heating surface of a steam boiler varies in its efficiency, according to its location with respect to the furnace. Take, for example, the return tubular boiler. One square foot of plate just above the grate, in front of the bridge wall, where the heat is greatest, is of far more value than the same amount of surface in one of the lower rows of tubes, or a square foot of shell near the rear of the boiler and high up along the side. Indeed, the amount of heat transmitted by the lower rows of tubes is such a small percentage of the total amount transmitted, that they have been plugged up, during certain tests, without appreciably affecting the evaporative capacity of the boiler.

The application of the term "efficiency" to the heating surface is simply for purposes of comparison, the efficiency being measured by the heat units transmitted per unit of time through a section of unit area, or, say the heat units transmitted per square foot per hour. This is a variable quantity, having different values for different portions of the boiler heating surface.

However, the position alone does not wholly govern the rate of heat transmission. The amount of heat transmitted through any surface or shell depends upon the difference of temperature of the hot and cold bodies, the amount of heat transmitted being proportional to the difference of temperature. Now, in a steam boiler working under fairly constant pressure and having clean surfaces, the water side of the shell is practically of constant temperature. Consequently, by increasing the temperature of the furnace gases an increased rate of evaporation may be secured.

But here arises another condition. All the heat given up by the gaseous products of combustion to the plates must be transmitted by the plates to the water, and that at the same rate as it is received. For if the heat is not transmitted as fast as it is received, the plate will become hotter and hotter until a danger point is reached. This is precisely the action which takes place when a plate is badly scaled. The incrustation prevents the close contact of water and shell and consequently the heat accumulates in the plate until it is burnt, or forms a bag.

In order that there shall be a uniform rate of heat flow, the water must take away the heat from the plates at the same rate as it is imparted to them, and this necessitates what is known as circulation. The more rapid the circulation, the greater the amount of water passing over a given area in a given time, and therefore the more rapid the convection of heat. But the advantage of a swift circulation does not lie in this alone. It keeps the various parts of the boiler at a more nearly constant temperature and tends to prevent, to a certain extent, the deposit of sediment on the bottom plates.

The efficiency of the heating surface is then found to depend upon two factors. First, the difference of temperature of the water and fire surfaces. Second, the rate of circulation. The former of these takes into account the material, the thickness and the condition of the shell, as well as its location in the boiler.

The catalogues of boiler manufacturers indicate a considerable difference as to the value of a square foot of heating surface. This difference is not due simply to differences in type or construction of the boilers, although this may in a large measure account for it. One builder will advertise a horizontal return tubular boiler of 100 units evaporation capacity, and give it 12 square feet of heating surface per unit. Another maker will advertise the same type and the same capacity of boiler at 15 square feet per unit of evaporation. Both boilers, when put into actual operation, may develop the stated capacity, but it is evident that the one with the smaller heating surface will need to transmit the greater amount of heat per unit of surface. The use of a boiler with small heating surface may or may not be economical. For the same fuel, the smaller boiler will need to have a higher rate of combustion than the larger, and this is not always economical. In

other words, the evaporative capacity of a boiler is not measured by the extent of its heating surface, and boilers should not be purchased simply on the strength of data concerning the amount of heating surface they contain. The quality of fuel to be used, is a factor upon which a great deal depends. What difference does it make if one boiler does possess 300 square feet of heating surface in excess of another boiler of the same type, if they produce the same amount of evaporation in a given time? Their relative values do not depend upon the relative heating surfaces, but upon the efficiencies; that is, upon the relative percentage of total heat supplied in the fuel which each utilizes in the evaporation of water.

Water tube boilers are commonly rated as having 10 to 12 square feet of heating surface to each unit of evaporation, as against 12 to 15 for the return tubular. The reasons for this may be found in the statements already given. In the first place, the currents of hot gases are more thoroughly broken up and are brought into more intimate contact with the heating surfaces, thus compelling them to give up their heat more readily. This is due, largely, to the method of placing the tubes. In nearly every type of water tube boiler, the tubes and baffle plates are so arranged as to cause the hot gases to pass as nearly as possible at right angles to the axes of the tubes, for the reason that more heat is given up when the currents impinge against the tube surfaces perpendicularly than when they run parallel to the surfaces.

Again, the tube thickness is considerably less than the thickness of a shell boiler to withstand equal working pressure, and consequently, the transmission of heat is more readily obtained. Still further, there is the advantage of a far more rapid circulation, inasmuch as there are no conflicting currents. The cooler water flows down one water leg into the tubes and out at another water leg or header at a higher level, the inclination of the tubes, in straight tube boilers, tending to facilitate a rapid circulation. In the return tubular boiler, the circulation is along the bottom of the shell from back to front, then up and back to rear and down again. But owing to the tubes and the cross currents set up by local disturbing currents, the circulation is somewhat less perfect.

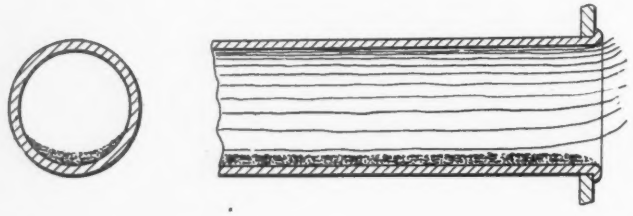


Fig. 1.

From what has been given, then, a number of conclusions may be drawn. First, the most valuable and most efficient portion of the heating surface of a boiler is that which is exposed to the direct radiant heat from the furnace. This would be the lower front sheet of a return tubular boiler, the crown sheet, and rear tube sheet of a locomotive boiler, the tube surfaces immediately above the furnace in a water tube boiler, the upper part of the flue containing the grates, and the furnace sheets and lower rows of tubes in a vertical boiler of the porcupine class.

While the surfaces exposed to the radiant heat are the most efficient, yet they must not be crowded too close to the fire. If this is done, smoke will result, especially with bituminous coal as fuel, since the water cooled plates will chill the partly burned gases and prevent further combination. And also, to maintain efficient heating surface, it is absolutely necessary that they be kept clean and free from incrustation, both internal and external.

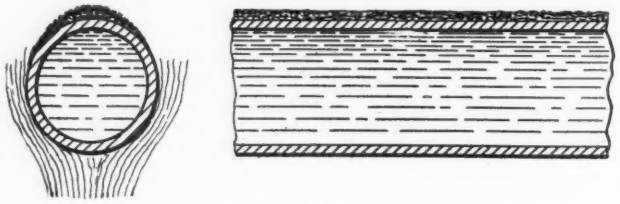


Fig. 2.

In calculating the heating surface of a boiler, it is customary to consider the entire area of the tube surfaces, as though heat were transmitted through all parts of it with equal efficiency. This is not the case. Take, for example, the ordinary fire tube of the return tubular boiler. The hot gases, in passing through the tubes, tend to rise by reason of their lightness, and so move along the upper inside surface, as illustrated in Fig. 1, which would seem to show that the upper side of the horizontal fire tube is most efficient. Not only that but dust and soot collect along the lower interior surfaces of fire tubes, as shown in the figure, and this layer of dirt further tends to lessen the amount of heat transmitted through the lower part of the tube.

With water tubes, the conditions are reversed. The hot gases strike the lower side of the tube, as shown in Fig. 2, and the greater part of the heat is transmitted through this portion of the tube surface. In case the tube is vertical or inclined, the side against which the currents of hot gases strike will transmit the most heat. In the case of the vertical fire tube boiler, there is a uniform distribution of the heating effect, but those portions nearest the furnace are most effective. This last statement, indeed, applies to all types of boilers.

———o———

The Production of a Vacuum.

A vacuum, by definition, is a space entirely devoid of matter. That is, it is a space that contains nothing; no oxygen, no hydrogen, no air, no water, no pressure. It is for this reason that a perfect vacuum in practice is very difficult to obtain, especially as applied in a steam engine, as a liquid when in the presence of a vacuum generally gives off some vapor, owing to the fact that the surface is more or less in tension, besides its usual evaporative quality. Among all the liquids it has been found that mercury, on account of its very high specific gravity, can be best used to produce a vacuum and maintain it, and it is for this reason that the words "vacuum" and "inches of mercury" are synonymous.

As everyone knows, the atmosphere has a certain weight which is recorded in pounds per square inch and the instrument for measuring this weight or pressure is called a barometer. A barometer in its most simple form can be made with three things; an open dish, a glass tube about 34 inches long,

sealed at one end, and sufficient mercury to entirely fill the tube and partly fill the dish. To construct it, the tube is entirely filled with mercury and the dish partly filled. The tube is then inverted very carefully and the open end immersed in the mercury below the surface and the tube placed in a vertical position, as shown in Fig. 1. The mercury in this tube will then be found to be 30 inches above the level of the mercury in the dish if the conditions of the atmosphere are normal, the space above the mercury in the tube containing a vacuum. As the pressure of the atmosphere increases or decreases, due to atmospheric conditions, the mercury in the column rises or falls but with this small variation the engineer usually has nothing to do. What he does care about and what is fixed in his mind is that a column of mercury 30 inches high will be balanced in a vacuum by the pressure of the atmosphere.

It is for this reason, since the mercury is in equilibrium, that the column of mercury must weigh exactly the same as a column of air of the same cross section which supports it and it is from these calculations that the pressure of the atmosphere can be derived. For instance, a cubic inch of mercury weighs 0.4908 pounds, so that the pressure at the foot of the

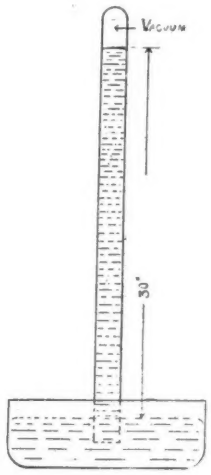


Fig. 1.—Mercury Column.

column 30 inches high is .4908 x 30 = 14.7 pounds per square inch, which as is well known, is the pressure of the atmosphere. Since a perfect vacuum is then equivalent to 30 inches of mercury, an imperfect vacuum, the kind with which an engineer deals, is equivalent to some height of mercury less than that and if the exact absolute pressure in a condenser be required, multiply the inches of mercury by the constant 0.49 and subtract the result from 14.7.

The particular feature that makes steam valuable in producing a vacuum is the fact that when it is condensed, it decreases 1600 times in volume and except for this small quantity of water and some vapor which even cool water gives off in a vacuum, a perfect vacuum would be established and it is only necessary to draw off the condensed steam and vapor by proper apparatus to enable the vacuum to be maintained which the condensation has created. The apparatus for doing this is called the air pump and the reservoir in which this condensation takes place is called the condenser.

The condensation of steam in the condenser is effected in two ways. The exhaust steam either meets in direct contact with the water which is to condense it, or, the steam impinges upon metallic surfaces which are kept cool by the circulation of cool water in contact with them. In the first case the condensed steam and the condensing water meet and mingle. The con-

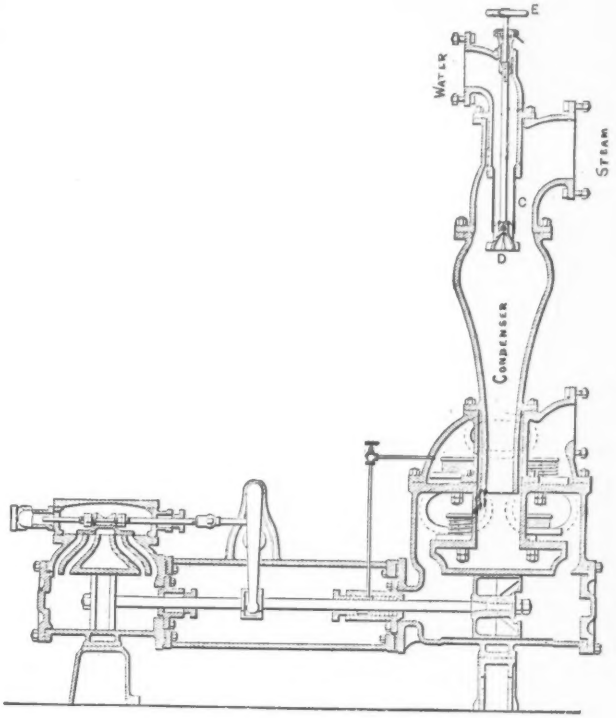


Fig. 2 —Jet Condenser.

denser is an iron pot or shell into which the steam is exhausted and the cooling water enters it in the form of a jet or spray, as shown in Fig. 2. Such condensers are called jet condensers for this reason and the cooling water is called the injection. All water that is used for cooling the condensed steam is therefore called the injection water.

When the condensed steam strikes cool surfaces and is condensed by those surfaces, the condenser is called a surface con-

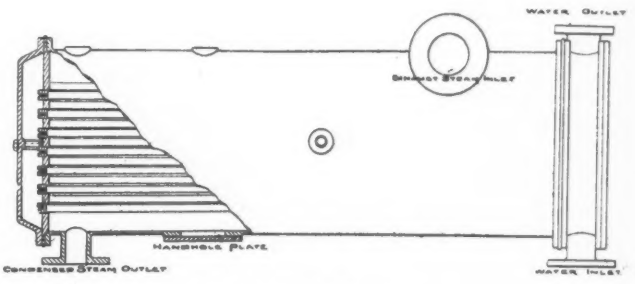


Fig. 3.—Surface Condenser.

denser, as shown in Fig. 3. The cooling surface is usually a surface of pipes or tubes made of brass or copper to secure a rapid transfer of heat. These tubes are usually coated on both sides with tin to prevent corrosion and in marine practice are made ⅝" in diameter. In some cases, condensation is effected by bringing the exhaust steam in contact with the outside of the tubes, the circulating water being on the inside,

while in others, the steam is exhausted into the tubes, the circulating water being on the inside of them. As both methods have their advantages, it is a question of design as to which is the better. Stationary practice in this country generally allows the water to circulate through the tubes with the steam on the outside. The steam enters the surface condensers usually at the top and the cold injection water usually at the bottom. This plan secures the greatest difference of temperature in all parts of the condenser. On account of the changes in temperature to which the tubes are exposed, it is necessary to arrange for expansion and contraction where the tubes go through the heads so as to prevent leakage. This has usually been done by making one end fixed and the other ends fastened in a stuffing box arrangement permitting the tubes to slide in it.

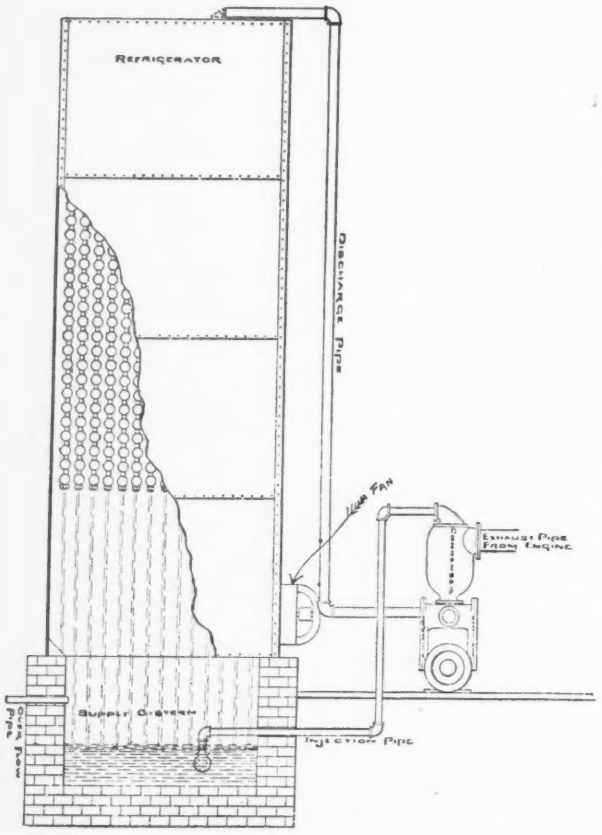


Fig. 4.—Cooling Tower.

In the jet type of condenser in which the water acts directly on the steam, the injection water will give a lower temperature with less amount of water and less apparatus than a surface condenser. The amount of injection water varies from 20 to 30 times the weight of steam to be condensed in cool seasons and from 30 to 35 times the amount in summer season. With this type of condenser, if the condensed steam is pumped back into the boiler, the injection water goes with it and consequently the injection water must be of good quality and not objectionable for use in boilers. In a surface condenser the injection water can be any quality, as it does not mingle with the condensed steam, this steam being distilled water with no other impurities than the lubricating oil, and is therefore the best water that can be pumped into the boiler if the oil can be extracted from it. It is for this reason that surface condensers are universally used for sea-going vessels and very much used on land in places where the feed water is injurious to the boiler.

In places where the cost of the injection water is excessive, it is of importance to use the same injection water over and over again, but this cannot be done unless the water is first cooled. There are numerous methods by means of which this is done. All of these methods utilize the principle of spreading of the injection water in the way best calculated to bring the greatest surface in contact with the greatest quantity of air so that evaporation may take place quickly and effectively. This is sometimes done by pumping the water through a number of spray nozzles up into the air, allowing it to fall into a lake or cold well below, or, as is more usually the case, the injection water is allowed to descend in a tower in a fine state of division over tiles or wire gauze or corrugated surfaces. A current of air, either forced by a fan or drawn up through it, causes a vaporization of the film of warm water pouring over the different surfaces, and the air cooling and the evaporation combined withdraw the heat from the water so that when it reaches the bottom it is in condition to be used again. Fig. 4 represents a cooling tower in which the air is forced up past the water which is trickling down the hollow tubes.

Cooling towers are used with either jet or surface condensers and can be used either with or without a fan, depending upon the design. In general these towers usually lower the temperature of the water from 120 degrees to 80 degrees, which is sufficient to maintain a vacuum of about 26 inches. As they depend chiefly upon the results of evaporation to do the cooling, they work better on a dry day than when the air is humid. When water evaporates, it requires a certain amount of heat to do it and as this heat is supplied from the adjacent particles of water, it frequently leaves them at a temperature below the atmosphere.

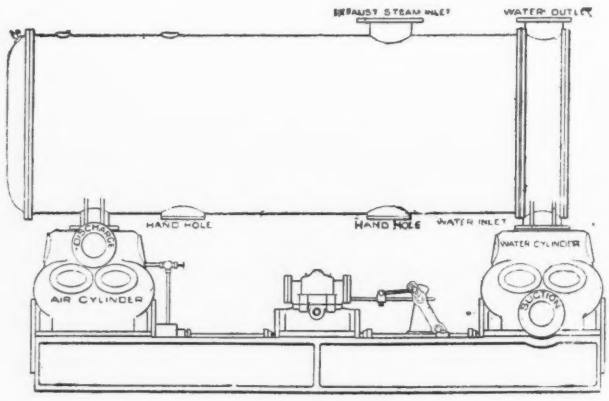


Fig. 5.—Surface Condensing Set.

The vacuum that is produced by condensing the steam must be maintained in the condenser as the condensed steam and injection would rapidly fill the condenser if no means were taken to empty it. Besides this, all water and steam contain a certain quantity of air which is not condensed and whose presence in the condenser would soon destroy the vacuum.

The pump which does this, together with pumping out the condensed steam and injection is called the air pump. In the surface condenser, as the injection does not mingle with the condensed steam, the air pump has nothing to do with the injection but is only required to pump out the

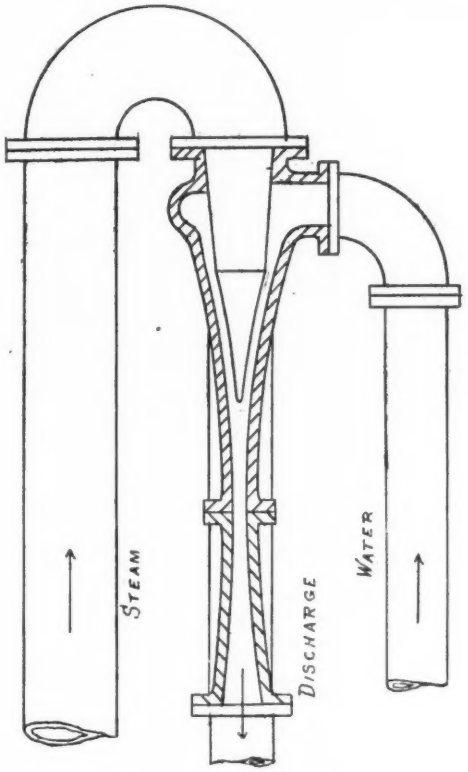


Fig. 6.—Injector Condenser.

condensed steam and air which get into the condenser; the pump which takes care of the injection is called the circulating pump. A compact arrangement of surface condenser, air pump and circulating pump is shown in Fig. 5. When large quantities of water are used and the difference in level through which the water must be raised is slight, centrifugal pumps are often used.

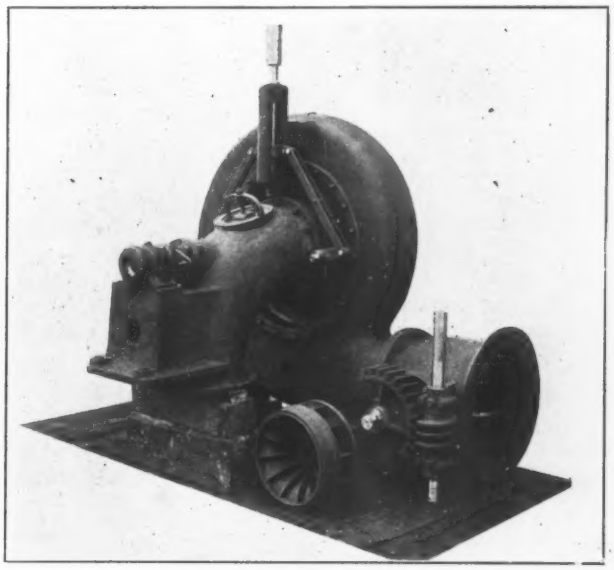
The pressure of the atmosphere will also balance a column of water in a vacuum the same as a column of mercury but the height of the water column must necessarily be greater on account of the lesser weight of the water. A cubic inch of water weighs 13.6 times less than a cubic inch of mercury, so that the column of water which the atmosphere must balance must be 13.6 higher or $13.6 \times 30 = 408$ inches which is equivalent to 34 feet. A water barometer can then be made in a similar manner to a mercury barometer except that instead of a tube slightly over 30 inches in length, a tube over 34 feet in height must be used. Advantage of this fact is taken in the so-called gravity condensers which require no air pump, the condensing apparatus being placed about 34 feet above the level of the hot well, the discharge pipe being sealed by always keeping its lower end below the level of the water in the hot well. The fundamental arrangement is shown in Fig. 6. The exhaust steam from the engine receives a downward direction in passing through the goose neck and passes through the inner cone which is surrounded by water and is condensed. As the water passes down, the contracting outline of the condenser brings it into a solid jet in the neck below through which it travels at a high velocity due to its pressure. The air which has entered the condenser with the water or with the steam or due to leaky joints is thus drawn down together with the uncondensed steam into the hollow cone of water below and expelled through the neck. The air and vapor having passed the contracting neck enter the tapering nozzle below and expanding therein are prevented from returning to the vacuum being continually formed above.

Modern Swiss and Italian Hydraulic Turbine Plants.

By Frank C. Perkins.

In the various hydro-electric power plants installed throughout Switzerland and Italy, a great many different designs of hydraulic turbines have been utilized, including the vertical as well as the horizontal types. It may be of interest to consider some of the horizontal types of Francis and other turbines constructed at Winterthur, Switzerland, and installed in these plants recently. The Rieter-Francis turbines at Ballorbes, Switzerland, operate under a head of 32 feet and are designed to receive the water below the horizontal shaft and discharge radially. These turbines were built by Rieter & Co. and develop 21 H. P. at a speed of 490 revolutions per minute, taking 200 liters of water per second.

The Francis turbine installed at Liesthal, Switzerland, differs from the above in that the water is taken in above the shaft but discharges radially in the same manner. The head in this case is 30 feet and the speed 260 revolutions per minute, while



21 H. P. Reiter-Francis Turbine at Vallorbes, Switzerland.

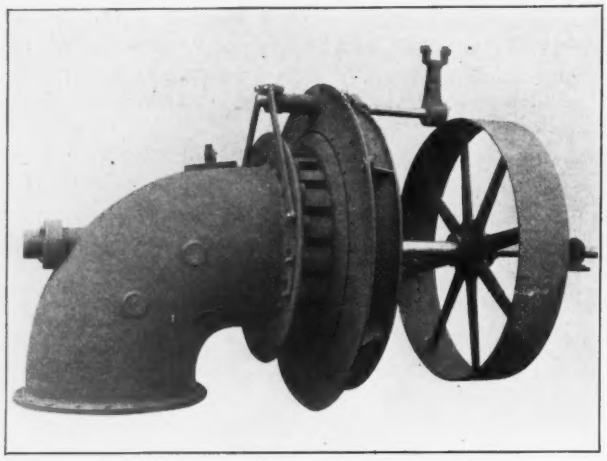
the power developed is 30 horse power with a discharge of 315 liters of water per second.

At Rheinsfelden, a still different form of Francis turbine is used. This construction has a horizontal shaft and is somewhat larger than the above, developing 50 horse power under an effective head of 14 feet. The speed is 118 revolutions per minute and the discharge 1200 liters per second. The

horizontal shaft Francis turbine installed at Tissage, Switzerland, is a single turbine in a conical iron casing, the water discharging from the center radially at the shaft at the rate of 500 to 600 liters per second. The turbine develops 45 to 72 horse power and operates at a speed of 240 revolutions per minute under an effective head of 30 feet.

The turbines installed in the electrical works in upper Italy were built at Milan by Riva, Monneret & Co. The necessary water for operating these turbines is obtained from the river Dora Belta and they have a capacity of 4200 H. P. with a fall of 45 feet, the flow of water being 30 cubic meters per second. These turbines are of the radial horizontal type and each have a capacity of 1000 H. P., the speed being 187 revolutions per minute. In this plant there are also two 150 H. P. turbines which operate at a speed of 400 revolutions per minute. They are directly coupled to direct current dynamos of 120 volts and supply the excitation current for the large 3-phase alternators.

The 1000 H. P. turbines are each directly coupled to an 850 K. W. 3-phase generator, supplying a current of 3000 volts pressure. These machines were constructed at Nurnburg, Germany. The 3-phase current is raised in pressure to 15,000 volts by 12 oil cooled step-up transformers. The power is transmitted by two lines, each about 25 miles in length, connecting the power house with the substations, where the pressure is reduced to 500 volts for distributing power to the various factories and shops.

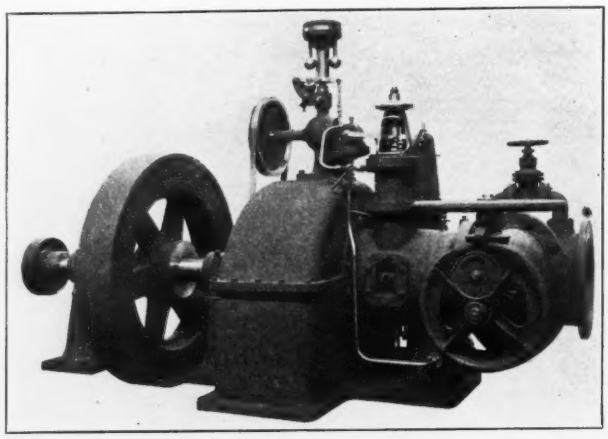


50 H. P. Francis Turbine at Rheinsfelden, Switzerland.

The various forms of horizontal turbines include the single turbine in an iron wheel case; the single turbine in open penstock; the double turbine discharging into separate draft tubes and the double turbine discharging into one common draft tube. A still different form of Francis turbine of the horizontal shaft type from those above described as to output, head and speed, is that installed at the plant at Glattfelden, Switzerland. The turbine built by Jacob Rieter & Co., of Winterthur, Switzerland, has an output of 128 horse power and a speed of 200 revolutions per minute. It has two moving wheels operating under a head of from 13 to 15 feet and discharging 3000 liters of water per second.

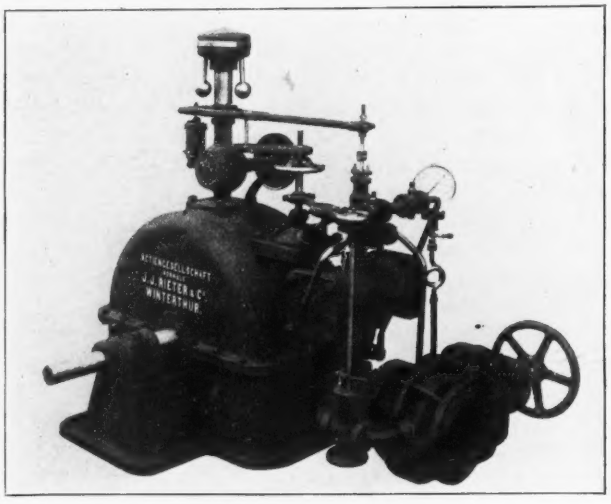
The various plants are equipped with turbines of different types, including those of both vertical and horizontal shafts. Among the latter may be mentioned the Francis, the Girard and the Pelton, all of which have been built at Winterthur, Switzerland, in various sizes and for different heads. Turbines of the Girard and Pelton types have been utilized largely in the mountains of Italy and Switzerland at places where the effective head is high.

At the plant at Bergamo, Italy, three turbines of 300 horse power capacity each of the Girard system are directly connected to alternating current generators. These turbines operate under an effective head of 260 feet and run at a speed of 500 revolutions per minute, using 375 liters of water per second. The governors are of the Rieter type and control the speed very closely. The exciters are directly connected to the turbines and alternator shaft outside of the main bearing of the generator.



300 H. P. Girard Turbine at Bergamo, Italy.

Another plant in Italy using turbines of the Girard type is that at Mondovi. These machines also operate at a speed of 500 revolutions per minute and they develop 200 horse power each. They work under an effective head of 300 feet, 210 liters of water being utilized per second. At this plant there are two groups of turbines each directly connected to an alternator.

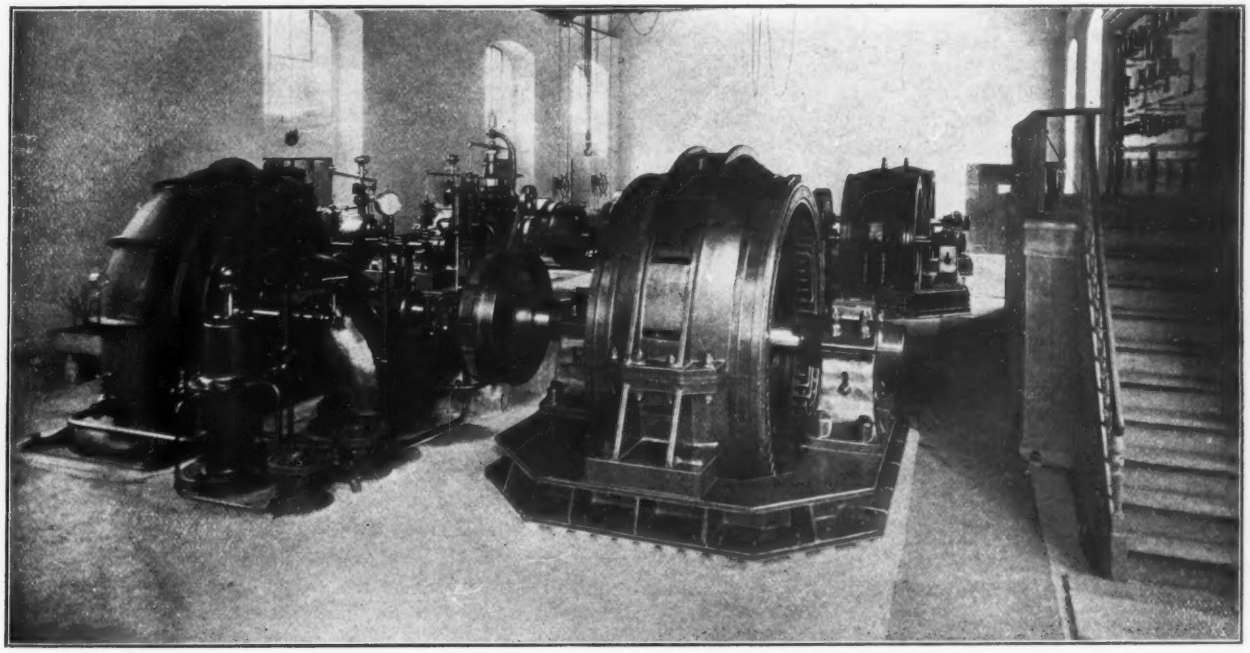


200 H. P. Girard Turbine at Mondovi, Italy.

The Pelton wheel has been constructed and used in Switzerland quite extensively. As built at Winterthur, the impulse

wheel is of solid construction, the buckets being bolted to the rim. One of these impulse turbine wheels has a diameter of 7.5 feet. A direct current generator operated by a Pelton wheel has been installed at the plant at Neftenbusch, Switzerland. This impulse wheel operates under a pressure due to a head of 380 feet. The dynamo is driven at a speed of 1100 revolutions per minute and takes 15 horse power, the water wheel taking only 12 liters of water per second.

Among the important plants in Switzerland using turbines of the Francis and Girard types is at Lauterbrunnen, where current is generated for the operation of the Jungfrau mountain railroad. The exciters of this plant are driven by Rieter-Girard turbines operating under a head of 110 feet. The generators are driven at a speed of 700 revolutions per minute, being directly connected to the water wheels which develop 25 horse power each, and utilize about 72 liters of water per second.



Interior of the Power House at Lauterbrunnen, Switzerland, showing the 800 H. P. Francis Turbines and Generators which generate current for the highest mountain railroad in Switzerland.

The large turbines at the Lauterbrunnen plant are of two types, the Francis and the twin Girard. The two Girard turbines have each a capacity of 500 horse power and are of the twin design with axial flow, working under a head of 115 feet and making 380 revolutions per minute with a flow of 314 gallons of water per second at full load. The generators connected with the Girard turbines are of the inductor type and are directly connected to them. These alternators are of the three-phase type and supply a current of 7000 volts pressure at a frequency of 38 cycles per second. The exciters are of the four pole shunt wound type and supply a current of 150 amperes each at a pressure of 120 volts.

The other two turbines in this station are of the Francis type and develop 800 horse power each. These turbines operating under a head of 100 feet use 2460 liters of water per second and run at a speed of 380 revolutions per minute. The alternators connected with the 800 H. P. wheels are also of the Oerlikon type and have an efficiency of 94 per cent. The armatures of these machines have each 72 slots with 36 coils, two slots being allowed per hole and per phase. Each winding has 20 conductors of two wires in parallel measuring in section 3.8 millimeters by 4.4 millimeters. The field magnet winding consists of 350 turns of copper conductor 8 millimeters by 8.6 millimeters in cross section. This hydro-electric plant has a floor space of 617 square meters, of which 318 square meters are utilized for a turbine and generator room and 24.5 square meters as a switchboard room, the balance being employed for repair shops, store rooms, etc.

The water is supplied from two sources: the Weisse Lutschine, with a capacity of 2650 horse power and a flow of 6 cubic meters per second, and the Schwarze Lutschine, with a capacity of 9000 horse power and a flow of 17.5 cubic meters per second. The Weisse Lutschine at Lauterbrunnen has already been developed and the water power of the Schwarze Lutschine in Burglauen is yet to be utilized. The total fall of 40.8 meters is obtained by conveying the water a distance of 1315 meters. The current generated at this plant operates the Jungfrau electric railway, which has a maximum grade of 25 per cent. and climbs to the summit of the Jungfrau, one of the highest of the Swiss mountains, 13,670 feet above sea level.

Pulverized Coal.

The use of pulverized coal for power purposes under a steam boiler has recently been investigated. According to the results, it was found that 7.5 pounds of water were evaporated per pound of pulverized coal when fired by hand. With mechanical stokers, 9.4 pounds of water were evaporated per pound of fuel. When reduced to the basis of combustible, the equivalent evaporation in the two cases was 8.4 and 10.4 pounds respectively.

THE REGULATION OF STEAM ENGINES.

Method of Speed Control. Cut-off and Throttling Engines.

PART V.

A governor that is somewhat similar to the McEwen governor except that is has a few more parts and does not have a dash pot, is the American Ball governor shown in Fig. 29. In this governor, the valve rod is attached to a wrist pin which is mounted on a plate, the plate being rotated about a pivot set eccentrically to the engine shaft. As the engine increases in speed the governor weights fly out and move the links connected to the wrist pin to which the valve rod is attached. This wrist pin moves the valve rod so that the eccentricity and angle of advance are varied, the variations being so proportioned that the lead is kept nearly constant for different changes in cut-off. In order to overcome any unnecessary friction, the spring is attached to the governor bar in such a way as to produce the least pressure on the suspension pin, lowering the friction on it and thereby increasing the sensitiveness of its action.

The tendency of all shaft governors, from those of the earliest design to those of the present make, has been continually toward simplicity, combined with stability and sensitiveness. A governor which fulfils these conditions admirably is known as the Rites inertia governor. This governor has been adopted by scores of engine builders who have adopted different designs of this governor to suit their type of engines. Figure 30 represents a Rites governor manufactured under the Rites-Carpenter patents and used on the Chandler and Taylor automatic cut-off steam engines. The Rites governor embodies both the centrifugal and inertia features by using a single weighted arm. No dash pots are required and it has

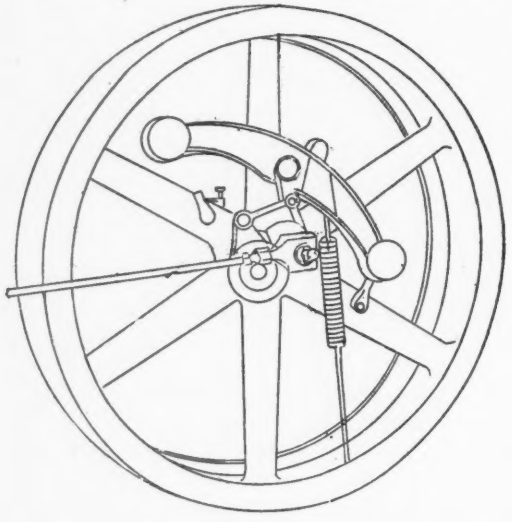


Fig. 29.

only one bearing. The eccentric to which the valve is connected is part of the governor arm near its centre, the motion of the governor arm being such as to shift the eccentric across the shaft and vary its angular advance. The governor weight in this design does not overhang the bearing pin but is supported on both sides, the pin supporting the inertia bar being large and oiled by a compression grease cup through numerous corrugations in the pin.

A form of Rites governor used on the Ames engine is shown in Fig. 31. It will be seen to consist of a weighted arm suspended upon a stud to one of the arms of the fly-wheel, the inertia of the weight and its arm being counteracted by a spiral spring. The valve rod is attached to a pin on the inertia

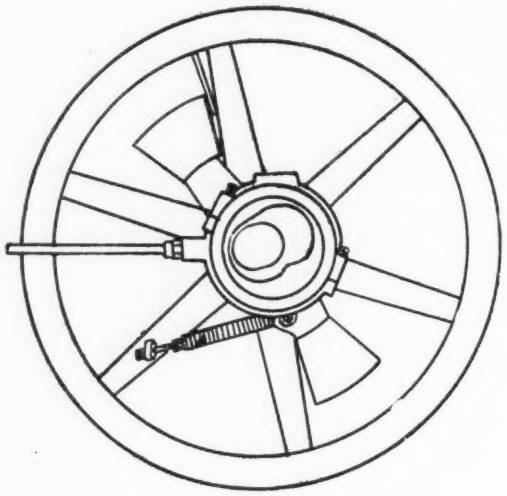


Fig. 30.

arm, which pin moves in an arc of a circle, the stud on which the governor is mounted being the centre. The motion of the pin being in an arc of a circle, both the eccentricity and angle of advance are varied.

The Payne governor, Fig. 32, is very similar to the Ames governor, the main difference being in the spring attachment and the angle of its pull. In the Ames governor the spring is attached to the rim, while in the Payne governor it is attached to one of the arms of the fly-wheel.

The action of the Rites governor depends upon the inertia of the weights, although a certain amount of centrifugal force is indispensable. The action of this type of governor is as follows: If the load on the engine is decreased, the wheel will jump ahead while the heavy bar will, due to its inertia, lag back and act in harmony with the centrifugal force, thus adjusting the valve to an earlier cut-off. If the load suddenly increases, the wheel will tend to slow down while the heavy bar will tend to continue at the same velocity, acting with the decreased centrifugal force to shift the eccentric to a later point of cut-off. For very gradual changes of load, the centrifugal force must largely take care of the valve as the inertia effect would then be very slight. This type of governor gives very close regulation when properly designed and adjusted. On account of the great portion of the weight of the bar being so far from the centre it is very strong in its action, permitting a close approximation to isochronism and consequently approaching a uniform speed throughout its range of load. Governors of this type have less centrifugal moment than those of other types and yet they are very stable because of the fact that the disturbing forces have less control over it and friction has been reduced to a minimum, there being usually only one joint. The fact that the disturbing forces have little effect makes this style of governor well adapted to handling heavy unbalanced valves. In order that the inertia and centrifugal features will act together, it is necessary to have the eccentric

swung from a pivot on the opposite side to the crank, which often gives a negative lead for early cut-offs.

While the greater number of modern engines are of the cut-off type, either employing a shaft governor or a pendulum governor, the throttling form of governor is still extensively used for some purposes. It is found upon examination that both types of engines have their advantages and disadvantages. One of the advantages of the throttling engine is that it is usually cheap in price, as it has a very simple valve gear and the throttling form of governor is inexpensive. As the engine has a fixed point of cut-off, the effort of the steam is exerted through a considerable portion of the stroke and there will therefore be less inequality of the steam pressure on the piston at the two ends of the stroke. The effect of throttling is to bring about superheating, which has a tendency to dry out the objectionable moisture in the steam and diminish condensation. For light load when the initial pressure of the steam is diminished, the range of temperature between the two ends of the cylinder also tends to decrease the cylinder condensation.

Some of the important disadvantages of the throttling engine are, it is not as sensitive as a cut-off engine and does not regulate as closely. It is uneconomical at heavy loads because the exhaust steam will be at a higher pressure than the atmosphere, causing the rejection of useful work in the steam. This in a cut-off engine is utilized by the use of an early cut-off and high expansion.

Some of the advantages of the cut-off engine compared to the throttling engine are as follows: The cut-off engine is more sensitive, immediately, to changes in work that it is to perform and just enough steam is admitted into the cylinder

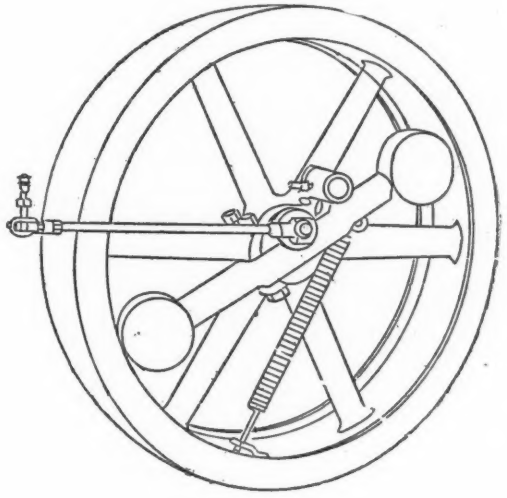


Fig. 31.

to do the work of one stroke. It is more certain to be kept at a fixed speed, since any change in the governor operates immediately to control the amount of steam required for the next stroke. The cut-off engine derives full advantage from the principle of expansion and uses the steam to the best advantage by working expansively. Among the disadvantages of the cut-off engine may be mentioned, that on account of the wide difference in the pressure in the cylinder and the external work to be done for different parts of the stroke, a massive fly-wheel must be used to take care of these wide variations and to give out in the latter part of the stroke the excess of work stored in the beginning. The valve gear is more or less complicated in this type of engine, which makes it more expensive than the throttling engine. The low temperature of the exhaust steam increases the condensation of the cylinder as the high pressure steam must strike the comparatively cool

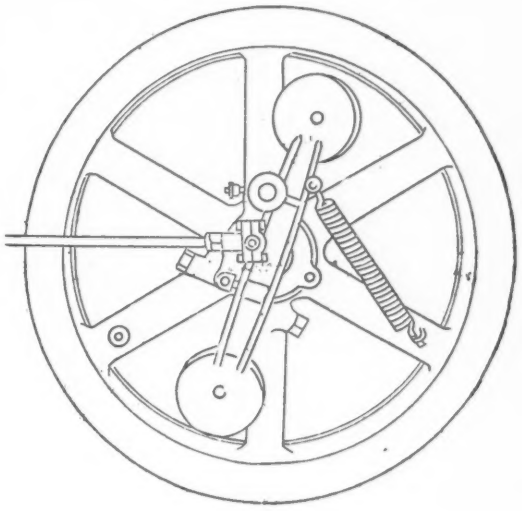


Fig. 32.

walls of the cylinder each stroke. It also sometimes happens in some form of engines that when the engine is very lightly loaded, the cut-off takes place so early that the final volume of the cylinder will be greater than that volume would fill at the pressure of the exhaust. This makes the expansion line cross the atmosphere line, thus forming a loop. This loop represents negative work and is a direct loss.

There are three principal defects of the throttling governor which interfere with its efficiency as a governor. The first of these is friction which arises from the joints and is caused by the method of hanging the balls and their weight. The second defect is due to the fact that the balls, as they assume different positions in keeping with the speed with which they revolve, are obliged to rise and fall. This is necessary in order that the resistance which the weights offer to centrifugal force should constantly increase. If it did not increase, the weights when once started from their lowest position would instantly go to the extreme limit of motion. The rising of the balls shortens the distance which they are allowed to move for a given variation by bringing the centre line of the arm on which they swing and the centre of the ball into a horizontal position so that a variation which moves the balls a given distance upward, if it occurs again, will not move them nearly so far in the same direction. So between friction which destroys the power of the balls for a slight change of load and the necessity for a large change to overcome their inertia, it is almost impossible to attain a close degree of regulation. The third defect in this type of governor is that the spindle or valve stem has of necessity to pass through steam tight packing boxes, which have to be screwed up to prevent leakage, which increases the friction and interferes with the action of the governor.

In the fly-wheel governor these defects have been practically eliminated. There is still a small amount of friction to be overcome but in the modern types this is made so very small as to become almost negligible. It is for these reasons that nearly all steam engines, except the roughest types, are equipped with governors which act upon the cut-off, making use of either the Corliss governor and valve gear, the Porter-Allen governor and valve or the fly-wheel governor, each of which has been fully described.

Peculiarities of Water.

Water, with the barometer at 30 inches, boils, in the open air, at 212° Fahrenheit and in vacuum, at 88° Fahrenheit. The less the pressure of the atmosphere, the lower is the temperature at which water will boil. The pressure of the atmosphere at sea level is 14.7 pounds per square inch, pressing equally and in all directions. This has been obtained from the following illustration: Because the height of a column of air of 1 square inch area exactly balances a column of mercury of the same area 30 inches in height, and also a column of water 33.86 feet in height, it follows that a column of air, 30 inches of mercury, and 33.86 feet of water weigh the same; and since the last two weigh the same, a full column of air must weigh the same and therefore give a pressure of 14.7 lbs. per square inch. A cubic foot of water evaporated under this pressure of one atmosphere, or 14.7 lbs. per square inch, occupies a space of 1700 cubic feet.

Salt water boils at a higher temperature than fresh water owing to its greater density, and because the boiling point of water is increased by any substance that enters into chemical combination with it. The density of water decreases as the temperature increases, since heat destroys cohesion and expands the particles, causing them to occupy greater space. The power of water to hold chemical substances, such as salts of lime, in solution, decreases as the temperature increases.

The law of expansion by heat and contraction by cold is true as relating to water, with this exception: that, as hot water cools down from the boiling point, it contracts until a temperature of 39.2° Fahrenheit is reached; but if it is cooled down from this point it expands again. In other words, from 32° to 39.2° Fahrenheit the density of water increases; above the latter temperature the density diminishes, because water is expanded into a greater space by an increase in temperature. Water has the greatest specific heat of all known liquids, except hydrogen, and is, therefore, taken as a standard for all solids and fluids.

Nearly every water used in manufacturing plants, for the production of steam, contains solids, which upon evaporation of the water, form boiler scale. This is well known to engineers generally, but it does not appear to be so well known in what manner that scale is formed, or what chemical reactions take place to cause the formation.

In order to divide these solids they may be classed separately as Sulphates and Carbonates. The Carbonates consist of the Calcium Carbonate and Magnesium Carbonate, both of which are held in solution by reason of their excess of Carbonic Acid. From a temperature of about 180° Fahrenheit to the boiling point and above, this excess of Carbonic Acid is driven off, and the Carbonate of Lime, or Magnesia, robbed of its solvent deposits. An exceptionally high temperature is not necessary to effect this separation, and it is for this reason that Carbonates are found to deposit in feed-water heaters, economizers, as well as at the point in the boiler where the feed-water enters into same.

The Carbonates when existing in a water without any Calcium Sulphate being present form a porous accumulation, varying from a crystalline to amorphous formation, and even occurring as a fine powder. The latter is more often the case when the feed-water contains in solution a considerable quantity of Sodium Chloride (Common Salt). Calcium Sulphate, which is held in solution by nearly every natural feed-water, and especially in England, is not precipitated at the comparatively low temperature mentioned. In an experiment made to prove this, a water heavily saturated with Calcium Sulphate was heated to a temperature producing ten pounds of pressure, but no precipitation of the Calcium Sulphate was caused. Some authorities claim that the separation, or the change of the Calcium Sulphate from solution to suspension, takes place on the surface of the water in the boiler. If this were a fact, the Calcium Sulphate scale would accumulate in those parts of a boiler nearest the water surface. The contrary, however, is the case, as scale of this nature invariably forms at the parts of the boiler which are exposed to the highest temperature.

It is for this reason that the actual separation from a certain quantity of water takes place the minute that quantity of water is changed into steam, and this change takes place at the point where the heat is transmitted through the iron of the boiler into the water. When an atom of water reaches a sufficiently high temperature to become steam it forms a minute globule, rises through the water to the surface, where the slight coating of water covering the globule breaks. At the point where this globule is formed, that is, at the heating surface, there being nothing to hold the Calcium Sulphate either in suspension or solution, it must separate, and forms a very small crystal. If the ebullition of the water permits it to do so it will adhere to the iron at the point where it had its origin, or it may be carried by the circulation until it finds something to which it can adhere.

The scale which is formed of Calcium Sulphate alone is very hard, but a formation of this kind is rare, the great majority of scales consisting of the three substances mentioned, as well as other mineral and vegetable substances. These latter substances, which are held in suspension by water, instead of solution, become part of a body of scale only mechanically. That is, they become part of a scale as sand becomes part of mortar, when mixed with cement. The cementing substance in scale is first of all Calcium Sulphate; Magnesium and Calcium Carbonate being secondary. Calcium Sulphate is the same substance known to everyone as Plaster-Paris. Calcium Carbonate exists in nature as marble, while Magnesium Carbonate is the same material used for covering steam pipes, to prevent the loss of heat.

From the very nature of scale-forming substances their accumulation is a source of trouble to the engineer and an expense to owners of plants. There are, no doubt, many cases where additional expense does not worry the engineer, but there are, no doubt, more cases where the additional trouble to the engineer does not worry the owner of the plant. There is no question, however, but that both would be benefited if the accumulation of the scale could be prevented and taken care of. The problem is a rather difficult one, as not only does each

source of water vary greatly in the scale-forming solids, but each individual source varies from time to time. If it were possible to compute the loss in fuel alone from this cause, the results would reach an enormous total, and would call the attention of the owners and engineers of plants to the great importance of the subject.

Large Pumps for Dredging Purposes.

An indication of the large amount of river and harbor improvement work now under way or contemplated by the United States Government is given by the fact that at present ten suction dredges are being built, two of which will be sent to the Great Lakes, two to New York Harbor, two to the Mississippi river, two to Charleston, S. C., one to Galveston and one to Savannah, Ga. The contracts for building these vessels have been distributed to a large number of builders, possibly for the purpose of hastening their completion.

The mechanical equipment of the dredges for salt-water

Twin Engines connected by bevel gears to Agitator on large dredge at Cape May, N. J.

service will include surface condenser outfits with air pumps, feed pumps, fire pumps, etc. The dredges for the Great Lakes are provided with very large cross-compound, double-acting air pumps and jet condensers with the usual complement of Blake vertical duplex feed pumps, fire pumps, etc. The air pumps are of a very novel arrangement, inasmuch as it is possible by the manipulation of valves and cocks provided for the purpose to cut each pump in half and run one side entirely independent of the other side. This practically provides a spare pump in each installation without the necessity of being overweighted with two duplicate machines, and at the same times secures the advantages of compound steam cylinders.

These dredges are the largest in capacity ever built and are designed in each case for the special work which they will have to do. They are self-propelling, sea-going dredges and do not depend upon the assistance of tugboats or other craft to move them around from point to point. Some of these vessels are fitted with immense bins in which the dredged material is deposited and, when full, the vessel propels herself out to deep water, dumps the sand or mud and steams back to repeat the operation. Others are arranged for depositing the dredged material into large scows fastened alongside the vessel.

The operation of these machines is very interesting. A long flexible tube 12 to 15 inches in diameter drops down from the side of the vessel 20 to 30 feet or more to the bottom of the river or harbor upon which the dredging operation is being performed. The upper end of this tube is connected to an immense rotative centrifugal pump revolving at several hundred revolutions per minute and capable of handling many hundreds of tons of water per hour. The lower end of the tube is manipulated from the vessel against the sand bars and mud banks and as the water is sucked upward by the centrifugal pumps a very large proportion of sand and mud goes with it. The centrifugal pumps discharge this water with its suspended material into the tanks on board the vessel or into scows, where the heavy material quickly settles to the bottom, the water flowing back into the sea.

Another large dredging operation is being performed at Cape May, N. J., where millions of dollars are being spent for the double purpose of making a large harbor and filling in the shore along the coast for cottage and hotel sites. The largest dredge of this operation contains a triple expansion condensing engine 14" x 27" x 42" with a 30-inch stroke directly connected to a centrifugal pump which has a capacity of displacing 20,000 cubic yards in one day when the mixture contains 10 per cent. of solid matter. The boilers, of which there are four, are of the Scotch return tubular type, the surface condenser and air pumps being of the usual types.

The interesting parts of this dredge which is called the "New Pittsburg" are the cutter engines and agitator. They are situated in the front of the boat and are controlled entirely from the pilot house. The twin cutter engines drive, by means of bevel gears, an agitator which is located on the end of the suction pipe. These cutter engines revolve the agitator so that it cuts the solid matter, preventing the suction pipe or centrifugal pump from becoming choked. This whole arrangement of cutter engines, agitator and suction pipe is mounted on the jib, which can revolve or move in any direction so that all the steam pipes and suction pipe have universal joints. The accompanying illustration shows the cutter engine suspended from the jib, the agitator being about 40 feet under the water surface.

The mixture of sand and water which is drawn up the suction pipe is forced a distance of 3800 feet through a 30-inch pipe to the place where it is to be deposited; the water draining off allows the solid matter to remain.

Deterioration in Grates.

The principal cause which contributes to the rapid burning out of the grate bars in a boiler is the action of the furnace heat, which will in time destroy any set of grates, but the want of a proper flow of air through the grates will cause overheating, whether it occurs through too little air-space in the grates themselves, or by these spaces becoming obstructed through any cause, thus preventing the cooling effect of the air on its passage to the fire. Another reason is found in the impurities of the coal, and especially in the chemical combinations of sulphur and iron, which impurities are found in more or less quantity in all coals. Any coal which forms an easily fused clinker will injuriously affect the grates.

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Boiler Furnace Efficiency. When coal is burned, to secure the maximum heat from it, every atom of carbon must be allowed to unite with two atoms of oxygen forming the complete product of combustion known as carbon dioxide. If too little air or oxygen is allowed to combine with the carbon, the resultant compound is called carbon monoxide, in which one atom of carbon and one atom of oxygen combine. When the former combination is allowed to take place, 14,500 heat units are given off for every pound of carbon burned, while the combustion of one pound of carbon with an insufficient supply of oxygen, will give out only about one-third as much or 4,400 heat units.

In the burning of anthracite coal, it is usually not the insufficient supply of air that prevents the maximum amount of heat to be liberated in the boiler furnace, but the excess of air, which is very likely to so cool the furnace gases as to reduce the temperature of the fire and carry the heat up the chimney that should be given to the boiler surfaces. This is a waste which is often never detected, as there is nothing in the average boiler plant to indicate it. It can only be found out accurately by the analysis of the flue gases as they go up the chimney. This analysis, which with up-to-date apparatus is very simple, will indicate at once if there is not sufficient air admitted to the furnace or if there is an excess, so that the method of firing and the draft can be regulated to obtain the maximum efficiency.

When bituminous coal is used, while this analysis will indicate exactly what is going on in the furnace, the difficulties are not so easy to remedy. The conditions under which bituminous coal is often fired are generally not of the best, and it requires skill and a great deal of hard work under the best of conditions to fire it properly. The incomplete or incorrect combustion of bituminous coal can be easily noticed by watching the outlet of the chimney and it is for this reason that the attention is more often drawn to it.

Bituminous coal consists of, approximately, 82 per cent. of carbon, 5 per cent. of hydrogen, 6 per cent. of oxygen, 1 per cent. of nitrogen, 1 per cent. of sulphur and 5 per cent. of ash and it is the object of every fireman to burn this combination without the production of smoke. This black gas or smoke is given off from bituminous coal at a low temperature and is a combination of carbon and hydrogen, called a hydrocarbon. The heating power of this compound greatly exceeds that of carbon itself and it is the duty of the boiler to heat and ignite this hydro-carbon, which when done properly, results in a transparent gas of carbonic acid and water. In another column of this issue will be found an article describing this important subject which is especially timely, as this smoke prevention, aside from its important bearing on the efficiency of the furnace, is becoming a matter of municipal importance, owing to the pollution of the air with its disagreeable results.

Alternating Current Frequency. There are many factors that enter into the selection of the proper frequency for an alternating current plant but at the present time these frequencies are limited by the manufacturers of alternating current machines to 25, 40, 60 and 120 cycles per second. The frequency of a commercial alternating current depends upon the work expected of it. For power, a low frequency is desirable particularly for converters. The large Niagara plant, the current from which is used chiefly for power, has a frequency of 25. Lamps, however, are operated satisfactorily only on frequencies of 40 or more, 60 cycles being very common for lighting practice. Early alternating current machines had a frequency as high as 125 and 133 cycles per second but these were soon abandoned because of their increased losses and their unadaptability to the operation of motors and similar apparatus.

In speaking of frequencies, it is common to call those above 60 cycles high and those below 60, low. With high frequencies, transformers are smaller and cost less than those of lower frequency because for the same voltage and flux density, the product of the iron cross section and the number of turns varies inversely as the frequency. The size of the wire required is the same for the same capacity regardless of the frequency. High frequencies permit the satisfactory operation of both

arc and incandescent lamps. Arcs do not operate satisfactorily on any frequencies below 40. Incandescent lamps of special design have been made to work satisfactorily on low frequencies by increasing the size of filament, which prevents any appreciable drop in the candle power between alternations but the standard 110 volt 16 candle power lamps fatigue the eye at any frequency under 40 cycles.

With high frequencies, the electro-motive force of self induction is greater, producing a greater line drop which tends to produce poor regulation at the points of distribution. The high frequencies also have the same effect upon the capacity charging current. It is the so-called wattless currents which are due to the effects of inductance and capacity, and which increase with the frequency, that lower the operative capacity of the generator, the transformer and the line, and the efficiency of operation. The operation of the synchronous motor and converter and the induction motor is more satisfactory on low frequency circuits.

For these different reasons, practice has demanded a compromise between the extremes of frequency, so that it is now generally found that power circuits are operated on 25 cycles, combined power and lighting circuits on 60 cycles and lighting circuits from 60 cycles up, the tendency being toward the lower limit.

Sixty Years of Electricity.

The wonderful progress made in the electrical industry has just been brought to mind by the fact that on May 24, sixty years will have elapsed since the first telegraphic message was sent from Baltimore to Washington. This first practical utilization of the electric current was due directly to the efforts of Prof. Samuel Morse, of Massachusetts, who crowned the telegraph with success by the addition of the Morse register and code and by the aid of the United States Congress who appropriated $30,000 for the building of the line between Baltimore and Washington. In connection with Morse's invention, it may be said that it would not have been successful without the invention of the electric battery by Galvani in 1790 and Volta in 1800, or the use of the electric wire by Weber in 1823 and the invention of the electromagnet by Prof. Joseph Henry in 1828. It remained for Morse, however, to put these things together and when on May 24, 1844, the notable message was sent, it started the world "ticking."

Since that time there has been a rapid development in this branch of the electrical industry until at the present time there are, in the whole world, 125,000 telegraph stations, 3,200,000 miles of wire, and 380,000,000 messages sent in a year. This wire will extend around the earth 125 times and the messages sent amount to more than one million daily, exclusive of cable messages. The Atlantic Cable was the outcome of the invention of the practical telegraph and after many difficulties the first cable was successfully laid on August 5, 1858, and on August 16th of the same year, Queen Victoria and President Buchanan exchanged messages.

The advance in progress along the other electrical lines has been equally as rapid. Prof. Bell's first patent on the telephone was granted in 1876 and on January 1st, 1900, there were in use in this country by one Company alone, 1,580,000 telephones with 1,016,000 miles of wire; the daily connections for persons using the telephone were 5,173,000.

In the past thirty-five or forty years, the growth of the dynamo and its application has been equally rapid. As a means of furnishing electrical power, the dynamo stands to-day at the head of the source of electrical generation. Until about 1865 the voltaic battery which generated electricity by chemical decomposition was practically the only means for producing electricity for industrial and commercial purposes. It was through its agency that the telegraph, the electric light and many other discoveries were made possible. Its cost and limited amount of current restricted the limits of its practical application but with the advent of the dynamo, electricity has taken a new and almost first place in the commercial activities of the world. It runs and warms the cars, it furnishes light, it plates the metals, it runs the elevators and in many ways has brought about a revolution of the arts and industries and even methods of war, since that first tick resounded in Washington sixty years ago.

The increase of the application of electricity in war is forcibly impressed by the conflict between Japan and Russia. The Marconi wireless system of telegraphy has been in daily use between the fleets of the Japanese and their armies miles away and it was reported that the Russian squadron at Vladivostok, having on board a set of these instruments intercepted one of these messages and retreated to the harbor. The powerful searchlights on board the war vessels and at the forts have been most valuable allies in preventing attacks, by turning night into day wherever their rays are directed.

This message of sixety years ago chronicled a more important event than the words which were transmitted, for it was in reality a message which inaugurated the reign of electricity. Great as the advance since that time has been, from all present appearances, the use of electricity is still in its infancy. The practical use of the trolley car dates back only to 1885, the storage battery is still to be perfected, while the telautograph, an instrument which records not only the words of the message of the sender, but records those words in the exact handwriting in which they were written, has just come into practical use. With these things in mind, it can be truly said that the next three score years will be quite as marked in the extension of the use of this powerful and useful agent as the last sixty years have been.

Notes on Burning Bituminous Coal.

A paper on this subject was recently read before the Engineers' Club, of Philadelphia, by Mr. John M. Hartman, who has given a large amount of study to the problem.

The paper describes clearly the reason why smoke, with its consequent evil effect on the atmosphere and loss of efficiency in the boiler, is produced and the means by which it can be remedied. The following explanations are first given: tarry vapor, hydro-carbon, and smoke are in this paper spoken of as black gas—a rich gas of far higher heating power than the carbon. Bituminous coal is spoken of as bituminous. The color-scale here referred to is a scale formed of one thickness of gray glass capable of cutting off 60 per cent. of a sixteen candle-power light, which represents No. 1 scale. Two thicknesses of said glass is No. 2 scale, and four thicknesses is No. 3 scale.

Bituminous consists of carbon, hydrogen, nitrogen, oxygen, sulphur, and ash. Powder some of this bituminous and sprinkle it thinly on a red-hot plate, say, at 800 degrees; it gives off a thick black gas or tarry vapor with a strong bituminous odor. It is the hydrocarbon passing off at a low temperature. The quick liberation of this black gas causes the difficulty in burning bituminous, as it gets away from us before we heat it, ignite it, and make it do its work. To heat and ignite the black gas quickly is our duty. This can be done with heat stored up and replenished for that purpose. Sprinkle some of this powdered bituminous thinly on a glowing yellow plate, say, at a temperature of 2000 degrees; it ignites with a bright yellow flame which, seizing the free air around the plate, burns to a transparent gas—carbonic gas and water, without odor. The red plate develops a temperature of, say, 600 degrees; the yellow plate, say, 3000 degrees. The red plate means imperfect combustion, black gas, and loss; the yellow plate means perfect combustion, a clear atmosphere, and thrift.

Take another plate heated to, say, 400 degrees, the temperature of the boiler water, and hold it over the red plate while the black gas is passing off, letting it touch the plate. The plate becomes coated with soot, which leaves a strong bituminous odor. This soot is one of the best non-conductors of heat, and destroys the efficiency of the boiler by clogging the tubes. Taking the yellow plate again and sprinkling a thick layer of bituminous over it, the flame arising burns on the exterior only, as the air cannot get at the interior of the flame until it has reached far above the plate, and by that time the gas has expanded, which lowers the temperature and it will not ignite. Hold the 400 degree plate over the flame; soot will collect on it. Taking the yellow plate again, sprinkle some of the powdered bituminous over it—a yellow flame outside and black gas inside appear; then hold another yellow plate above it, where the flame is black outside. The black gas fires and combustion takes place. The gas and air being heated causes a quick combination of the two. We have with the upper yellow plate added to the black gas the heat of ignition and fired it; it then burns to its full equivalent of heat. In place of the upper yellow plate, let us substitute a yellow fire-brick to absorb heat. This will give heat to the gas and air and fire them; the gas burning at a high heat gives back to the fire-brick the heat which it gave to the gas. The brick also receives heat, after gas is all driven off, by the radiation from the coke fire below, which is glowing white, and exposes the brick to its direct rays. As soon as the bituminous is put on again, black gas is evolved and heat is absorbed by it; but the black gas is burned clear. This interchange of heat continues as long as the fire is kept up. In burning the black gas this radiant heat from above is the most effective. As the black gas rises, it expands, lowering its temperature, and it is then supplied with heat from above, which ignites it and thus does not rob the fire below. Burning the gas in contact with the brick above it, heats the brick, causing more heat storage. The fire-brick acts as a fly-wheel to store up heat and give it out again. By this means the gas is kept burning continuously.

After the black gas is volatilized, the heat taken up in volatilization is carried up the chimney and lost, if the additional heat is not present to ignite it. This deficiency of heat robs the fire when it is weak and results in the evolution of more black gas and an increase in waste.

In the burning of bituminous there are three absorptions of heat before perfect combustion takes place.

First: the heat to liberate the black gas.

Second: the heat to supply the gas as it expands.

Third: the heat to ignite the gas.

This shows that a glowing hot fire and ample heat storage by fire-brick are required at all times for perfect combustion.

To burn bituminous in a boiler these principles apply as well as on the plates described. The first thing to be done with a fire is to nurse it carefully until it attains a white heat. After this, a high temperature is to be maintained by small additions of bituminous, for it is only at this high temperature that the full equivalent of heat in the bituminous can be obtained from it. Whatever color there is in the smoke at the chimney-top represents a loss due to the black gas not being burned in the furnace or fire-box. If the red plate develops one heat unit, the yellow would develop, say, 4½ heat units with the same fuel.

The air required to burn one pound of bituminous is about 150 cubic feet for combustion to carbonic acid, but in practice from 225 to 300 cubic feet are used. This excess of air dilutes the heat of the fire-box and results in a loss. Much of this diluting effect can be avoided by heating the air, which will cause quicker combustion with both the coal and the black gas. Unless heated, this extra air does not get the proper time to combine with the black gas before it gets into the tubes, when further combustion is stopped by the tubes lowering the temperature below the point of ignition. Old firemen prefer to carry a thin fire and have all the air come up through the burning fuel. The only objection is that the engineer may open full stroke and tear his fire to pieces, if on a locomotive; hence the fireman has to carry a thicker fire than would otherwise be required, which makes more smoke. A check-valve at the bottom of the smokestack will correct this trouble. With a thin fire, more free air passes through the firebed, and being heated in its passage, it is in a better condition to unite with the black gas and burn it quickly. The regulation of the air is a serious question. When fresh fuel is added, black gas is evolved in large quantities, and an increase in the supply of air is required to burn it; but, the air being cold, combustion is checked to a certain extent; in addition, there are the three heat absorptions to further cool the fire. As the black gas is gradually driven off, less air is required. The air can be controlled by the fire-door being left partly open and then gradually closed as the black gas decreases. When the

fire is kept intensely hot, as it should be, the black gas will be burned before reaching the tubes. It is a question of the ratio of the heat units in the fuel plus the heat in the furnace or fire-box, and the time required for the mingling and combustion of the air and black gas before they reach the tubes or water surfaces of the boiler, as to whether we will have perfect combustion or not. An intensely hot fire to give a short quick combustion is the requirement in burning bituminous. The oftener the bituminous is added, the smaller and more uniform will be the volume of black gas evolved per second and the more attention is required, but the fire will be more steady. Perfect combustion and heat absorption by the water surfaces cannot go on at same time and place; some black gas will escape unburned.

In starting a fire in a stationary boiler, wood is placed uniformly over the grate and fired all over, cheap or spent oil being used. The fire-doors are left open to give plenty of air and keep down the smoke. When the wood has burned off all its smoke, place on the wood the old coke left from the last fire and let it burn up; then add bituminous lump slowly, giving it plenty of air until it is well ignited, after which the air can be regulated to suit the fire. The fuel must now be burned at an intense heat; and by successive additions of a single shovelful, of about 18 pounds, must be kept at this heat. This will give an escaping gas at the chimney-top of No. 2 scale or under. In operation, the fire is kept of uniform thickness, except at the corners and sides, where it is kept a little thicker to prevent the air from passing up too freely. It will require attention every three to five minutes to obtain good results and as nearly perfect combustion as can be gotten with a plain grate, for the black gas evolved toward the bridge-wall or tube-sheet will, by the cooler water surfaces, be chilled below the point of ignition.

James Watt in his day, finding the smoke nuisance so great, pushed his grate bars back from the front about 18 inches and put a dead plate in this space. On this dead plate he placed a bank of bituminous that was heated by radiation from the furnace; part of the black gas being driven off, and escaping over the fire, was ignited and burned before it touched the water surfaces. When it was time to re-coal the fire, this bank was pushed over the fire evenly and replaced with a fresh bank. With the slow running of those days there was time to drive off the greater part of the black gas from the bank, but for the rapid running of these days better means must be had to get the greater part of the black gas off in time for re-coaling. Where they used 60 pounds of bituminous per square foot of grate per hour, we use to-day 135 pounds successfully, and have little black gas from the chimney; but when we slaughter coal and use 180 pounds per square foot, we have immense volumes of black gas at the chimney and get no greater useful results than if we burned 135 pounds scientifically. The superintendents of the railroads have increased the engine end without caring for the grate end, and have piled work on the locomotive proportioned to the engine end.

When the bank of bituminous was pushed over on the fire, part of the black gas escaped at the chimney-top for one or two minutes, as the black gas in the interior of the bank had not been evolved. This arrangement was a help to prevent smoke, and is used to this day. Coking on the dead plate extends the time for re-coaling to, say, five shovels, and gives the fireman some leisure. These two methods of hand-firing are widely known and are not patented.

Another method by which a fire may be re-coaled so as to effect satisfactory ignition of the black gas is seen in the operation of the Hawley down-draft patent, consisting of a coarse inclined water grate placed over another grate inclined with bars closer together. Fire being started on the upper and lower grates, the bituminous is burned to coke, which is barred on the upper grate, and the smaller pieces passing the upper grate fall on the lower, highly heated, where they form a good body of coke. Bituminous being added to the top grate, the black gas is drawn down through the fire and fired in passing through the bed of burning coke on the lower grate. This grate works well, gives a high heat evaporative duty, but it requires work to bar the coke down to the lower grate and much attention on the part of the fireman. The chimney-top shows from No. 2 scale down to No. 0.

In hand-firing and machine stoking the fire requirement is that the black gas shall be burned to carbonic acid and water, giving a clear chimney-top. Second: the black gas must receive a full supply of air to burn it. Third: the black gas must be burned before it touches the water surfaces or the tubes. Fourth: the black gas must be evolved in time to burn before reaching the tubes. Fifth: the air to burn the gas must be heated to obtain a high temperature and make a short burn.

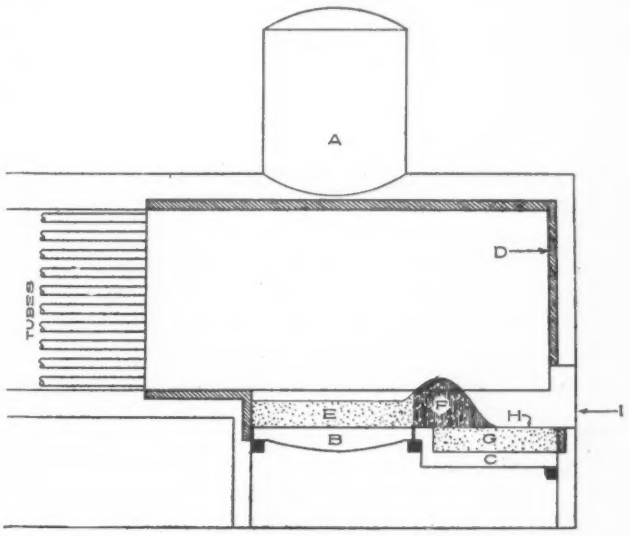

Fig. 1.—A proposed Grate for burning Bituminous Coal.

To make it easier for the fireman in hand-firing and give a good combustion, a grate of the type shown in Fig. 1 is proposed, in which A is an internally fired tubular boiler; B is the main grate with shaking-grate arrangement; C is the low-down grate with shaking-grate arrangement; D is the brick lining of the fire-box; E is the bed of coke burning on the main grate; F is the bank of bituminous; G is the bed of coke burning on the low-down grate; H is the space for the escape of gas from the low-down grate; I is the fire-mouth the whole width of fire-box.

The fire having been started on the two grates and burned to coke, a bank of bituminous is placed at F, where it is attacked below by the heat of the low-down grate, by the heat passing over it from H, and by the radiant heat from D, the

fire-brick lining, and the heat radiated from B. Black gas is quickly evolved and supplied with heated air from the space H, where the fire is thin to allow extra air, or more than is required for the combustion of the coke in C, to pass it and be heated in passing. This extra air being heated causes quick combustion, burning all the black gas before it reaches the water surface or tubes, where it would be cooled. Free air also passes through the coke at B and is heated. When the time arrives for re-coaling, a small portion of the coked bank F is scraped back into the space H to keep it full of coke and to give free passage to the air. The bank F is then broken up and pushed over the grate B, leveled, and another bank F made. This bank F holds back the black gas in its interior, letting it escape slowly and steadily, thus avoiding the necessity for large volumes of air at intervals, as would be the case if the bituminous were spread in a thin layer, resulting in a much quicker evolution of gas. The fire-mouth I has two doors covering its width. Re-coaling is done alternately at the two doors, thus getting the benefit of cross-firing. Driving the black gas off near the firing-doors gives ample time to mix the air with it before it reaches the water surfaces or tubes.

The fire-brick lining acts as an accumulator when the fire is at its height, by heat absorption before re-coaling. On re-coaling, the temperature of the fire is lowered, but the fire-brick gives out its heat and ignites the gas, keeping up thorough combustion. As the fire becomes hotter, the heat is again taken up by the fire brick and stored for the next re-coaling; thus a continual interchange goes on with thorough combustion, which prevents the formation of soot on water surfaces and tubes, thus contributing to the perfect conduction of the heat through the tubes to the water. Steam is made cheaper from the tubes than from the fire-box. One square foot of tube is equal to four square feet of fire-box surface, considering average temperatures.

Perfect combustion in the presence of water-cooled surfaces abstracting the heat from the burning black gas and in contact with them is not to be had. To get it, all combustion must be made in the presence of fire-brick or other non-conductor, hence the necessity of the fire-brick lining to the fire-box in burning bituminous. Lining the fire-box may require a slight addition to the tube surface for the same work; it would not be much, as we get a hotter fire and cleaner surfaces. The presence of the fire-brick will make less free air necessary for perfect combustion than is now used. It will save the crown-sheet from cracking and help in case of low water. It will prevent cold air from cooling the gas and stopping combustion when the door is open for re-coaling. To line the fire-box requires no special appliances. This lining is firmer than the arch now used and is not disintegrated by the coal, and while it is not so close to the fire, yet it does the work well.

The paper then goes on to describe three mechanical stokers that were found to be reliable, of which the Endless Chain Grate is the oldest. The grate is made up of a series of short cast-iron bars linked together and engaging sprocket wheels at the front and rear end of the grate, by the movement of which the upper portion of the grate is carried constantly forward. The bituminous is fed through a hopper of the full width of the grate, and the depth of the layer is regulated by a door which can be lifted or lowered. The coal is ignited near the front and is carried slowly backward, the speed of the grate being adjusted so that the time of travel is sufficient for the complete combustion of the fuel. The ash and refuse, being carried over at the back end of the furnace, fall into the ash-pit. The coke on the grate has to be broken up, from time to time, as it cakes. A fire-brick arch at the front end of the furnace facilitates the coking of the fresh bituminous as it enters, and the combustion of the volatile gas evolved. The apparatus, as a whole, is mounted on wheels and a track, and can be drawn out for inspection and repairs.

This stoker works well, but requires considerable repairs. It gives a clear chimney-top, but this is partly due to free air passing through the stoker. Its evaporation duty is medium. If called on suddenly for more steam, it does not respond quickly without producing a smoky chimney-top. It is applicable to an externally fired boiler.

In the Murphy Stoker the grate bars are arranged on opposite sides of the furnace and incline downward toward each other at the centre thé fuel being introduced at the top and fed downward toward the middle, in which there is a mechanical device for removing the clinkers. A fire-brick arch spans the combustion chamber. A coal magazine is located on each side of the furnace and is provided with discharge openings and coal pushers. The latter have a reciprocating motion imparted to each by a rocking shaft, rack and pinion. The inclined grate surface is composed of stationary and movable grate bars, alternately placed. The upper ends of the stationary grate bars abut against a compensating plate, which permits the bars to expand readily with the heat. The movable grate bars are connected to vibrating levers, from which they derive their motion. In connection with this motion the movement of the rock shaft imparts motion to the coal pushers in such a manner as to feed the coal just in proportion to the requirements of the furnace. The crushing and removal of the ashes and clinker are effected by a clinker bar at the bottom of the grates. The clinker bar is provided, on the outside, with teeth which extend spirally around the bar, and the approximate inner edges of the grate bearers are provided with similar teeth, to aid in crushing the clinkers when the clinker bar is rocked. The furnace is especially adapted to the use of bituminous slack, which is put into the magazines at the upper part on the sides of the combustion chamber. Air is admitted through a register at the front, passing through flues up over the arch, and there taking up heat from the front arch and arch plate, then passing down through the small openings in the arch plate to the coking fuel.

On the side of the battery of boilers is placed an engine with gearing for operating a reciprocating bar across the outside of the entire front, and to which all the working parts are attached by links. With steady work this stoker gives a perfectly clear chimney-top. The crust of coke has to be broken up by the fireman from time to time. This stoker requires more space, has more machinery, and is more costly than the other stokers, but it gives a clear chimney-top, delivers its own ashes and clinker, which accounts for more machinery. It is adapted only to externally fired boilers.

The Jones Underfed Stoker consists of a steam cylinder or ram, with a coal hopper, outside of the furnace proper; a retort or fuel magazine inside the furnace, on the sides of which are placed tuyere blocks for the admission of air. The retort also contains, at its lowest point, an auxiliary ram or pusher, which causes the coal to be evenly distributed. This

pusher is in a position where the fire never reaches. The retort is first filled with coal on a level or a little above the tuyeres. The fire is then started along each side of the retort, the air-chambers reaching to the tuyeres being open. As soon as the fire is well under way, the air-chamber opening is closed and the blower started; the fire will then burn up rapidly. The hopper being full of fuel, bituminous slack preferred, and the ram plunger on its forward stroke, when more coal is needed the plunger is shifted back by moving the lever; coal then falls in front of the plunger, steam is admitted to the cylinder, and the plunger is forced forward, pushing the coal into the retort. Coal is pushed into the retort as needed to replenish that which is consumed.

Air at a lower pressure is forced into the air-chamber and through the tuyeres over the top of the fresh coal in the retort, but under and through the burning fuel; the result is that the heat from the burning fuel over the retort slowly liberates the black gas from the fresh fuel. This black gas being thoroughly mixed with the incoming air, before it passes through the burning fuel, results in a bright clear fire free from black gas. The retort being air-tight from below and the fuel being in a compact mass, the air moves upward and combustion takes place only above the tuyeres. The retort is thus kept cool and is not subjected to the action of the fire. The incoming fresh fuel from the retort forces the ash and clinker over the top of the tuyeres on to the side plates, from which they are moved easily and without interfering with the fire in the centre of the furnace. Each time the ram pushes feed into the retort it pushes it upward at the same time; this action breaks up the crust of coke formed on top of the retort and eases up the fire in place of doing it by hand. As the black gas is liberated below the burning surface, it is heated and ignited by the burning surface of the fire. No cold air enters the furnace during stoking.

This stoker is applicable to externally and internally fired boilers, including those for locomotives. It gives a clear chimney-top, but uses an excess of air, unless the black gas is burned with a fire-brick arch, in which case it gives perfect combustion with no excess of air and a high evaporation. The fan supplying the air to the stoker is controlled by a valve, which when steam goes down admits more steam to the fan and stoker, thus starting them up faster and keeping up the steam. This stoker can be pushed up without producing smoke at the chimney-top, and it is the only stoker that can be applied to a locomotive. The fan used for stationary stokers would be replaced with an Argand blower. While the steam used in the blower will be mixed with the air going through the fire, which is not economical, yet there are advantages gained from it. With the Argand blower there will be no back pressure on the steam cylinder, crippling the exhaust. The fire being under pressure, the heat will be packed in the tubes and every square inch utilized. Boilers with heat under pressure always steam better than with suction for draft.

One of these underfed stokers was put in the end of a heating furnace at Pittsburg, replacing the old fire-grate. The furnace heated 6-inch wrought-iron billets. In place of the thick black smoke formerly escaping, the chimney-top is as clear as the air. The heating chamber is a beautiful glowing yellow at all times. With the same fuel and men, they are turning out twice the amount of work and of better quality, as the heat is so uniform and intense. This stoker has run eighteen months, and has required not a cent for repairs. It is adapted to puddling and other furnaces, which shows how perfectly it can burn bituminous without smoke and yet get the full equivalent of heat from it.

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LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

As Things Are Often Done.

EDITOR THE PRACTICAL ENGINEER:

Quite often the handling of valves is mentioned through the columns of journals treating on steam engineering, and numerous writers have laid great stress on the matter, but for all that, there is still a chance for saying more, for there is always someone who is about to, or has just taken up the profession of steam engineering and he is ready to read something of this and will benefit by it.

The writer has often seen engineers open and close a valve and when closing it, they would pull on the wheel on the stem until they would flush up in the face. I often wondered if they were blushing because they were showing their ignorance of the way to handle the valve. Oftentimes men will take a monkey wrench and put it on the valve wheel and pull to keep it from leaking water or steam. This not only ruins the disk but in time will ruin the best valve made. If a valve cannot be made water or steam tight without such treatment as this, it needs the attention of one who understands the way to care for them or a renewal of the disk or regrinding of the seat.

The writer has five 1¼ inch valves on a pump supply from the hot well and they have sometimes been in contact with hot water as high as 150°. These valves are opened and closed daily and they were there when I took charge of the plant eleven years ago and the disks are in good condition yet and do not leak. I never allow a wrench to be used on any valve unless it is to get a very close regulation of steam or water and then by placing it on the rim of the wheel and tapping lightly with the hand, but this should not be done if it can possibly be avoided. I have had the same make of valves on the blow-off pipes of the boilers with 100 pounds steam pressure. Some of the disks lasted over a year and on several occasions they lasted over two years, while in a plant close by this one mentioned above, the engineer was replacing disks every Sunday. He considered himself fortunate to keep one in three months, and the conditions were about the same, only this man was running on 80 pounds pressure, with the same make of valve and this engineer was always kicking because he could not make these valves hold. It was not the valves; it was the man. He did not understand the way to handle them as he used the wrench on them.

This same fellow would pull his fires on Saturday night at 5 o'clock and about 5.30 P. M. would open the blow-off valves and blow all the water out of them and let it stand until the next morning and then fill it up again for Monday.

On Monday morning he would come on at 5.30 A. M., fill his fireboxes with wood and leather chips and starting with cold water, he would have 80 pounds of steam on before 6.30 and all the talking that could be done would not change him.

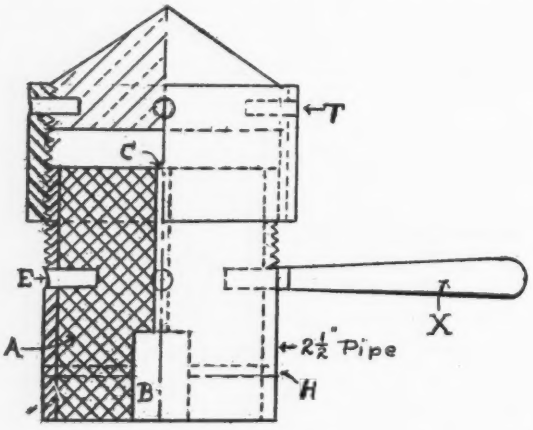
This man, when he went for his license, was asked by the examiner how he would set the valve of a slide valve engine, and he answered: "With the point of a jackknife." This man almost had a fit because he only got a third-class license, as he thought he ought to have a first-class unlimited license. I often watched this man fire his furnaces. It seemed the engine did not use the steam fast enough for him. He would open the fire doors and dig into his fires before they had time to burn up bright. With his damper regulator closed, and with the smoke and flames coming out of the fire doors he would try to get some more coal on. He worked for $1.50 per day and the employer thought he was saving money on this man.

Abington, Mass. A. T.

A Handy Ratchet.

EDITOR THE PRACTICAL ENGINEER:

At a steam plant where I work, we had some holes to drill and the distance between the wall and the part to be drilled was so small that we could not use our ratchet. So we made what we term a home-made ratchet. We took a piece of 2½" pipe and filled it with babbitt as shown at A in the sketch.



A Handy Ratchet.

We drilled out the lower end, for the shank of the drill, as at B, and a small hole all the way through for backing out, as at C. A hole was drilled at H, a little to one side of the hole B, for a pin, allowing the shank of the drill to pass by it, and preventing the drill from turning. Holes were drilled, as at E, to turn it. A cap was made of another piece of pipe by filling the upper end and drilling it with holes to turn it, as at T. The lower part left empty was screwed to part A and this furnished the feed. The pin was then driven into hole H and drill was placed in hole B, and the lever X was used to turn the body to make the cut and the upper part was used as a feed. The length over all was 6", including the drill. The size of the holes we had to drill was ¼ inch.

Cambridge, Mass. W. A. D.

The Engineers We've Had.

No. 1.—THE HOT-HEADED ENGINEER.

Yes! Bill looks gloomy now for he got fired out of the mill,
And if he'd kept his temper he'd be workin' up there still.
How was it? Well, I'll tell you, sir, for I was standin' by,
And what Bill did that day came mighty near to make me cry.
Bill always was hot-headed, and that day he went to fix
A pulley that got broken by one of the girls' tricks;
They're always up to devilment, or doin' something queer;
If I had to work with women I'd ne'er be an engineer.

Well, Bill called up the fireman to help out upon the job,
And as usual started swearin' fit to cause your heart to throb.
He cursed the girls, the pulley, and he cursed the fireman too,
His wrench slipped—hit his knuckles, then the air got pretty blue.
The pulley by a set screw had been fastened to the shaft;
Bill couldn't get it started, and it made him mighty 'daft.'
He pulled and tugged, and swore and spit, and slipped, and skinned his hand,
Then stopped and eyed the fireman, then said: "Well, I'll be d——d."

The fireman, plucking courage up, then ventured: "Kerosene
Is good sometimes to loosen screws when they are actin' mean."
"Oh, kerosene your grandmother!" yelled Bill, "don't speak, you lout,
I'm engineer, and don't forget I know what I'm about.
Go quick to my large tool chest, bring me back a larger wrench,
And don't stand there a gappin', or one of your lights I'll quench."
His words came true, but not the way he wanted, as you'll see,
The lump comes in my throat when that remembrance comes to me.

The fireman, goaded, made a move toward Bill who, seeing it,
Picked up the wrench and shouted: "Come nearer, just one bit,
And as I live I'll murder you." The fireman onward came.
Bill threw the wrench, the fireman dodged, that finished Billy's game.
For, right behind the fireman stood a fair-haired little lass,
And when he dodged to let the wrench that Bill threw at him, pass,
It struck her plumb, knocked out her eye.—It nearly made me weep
To see the little darling falling in a bleeding heap.

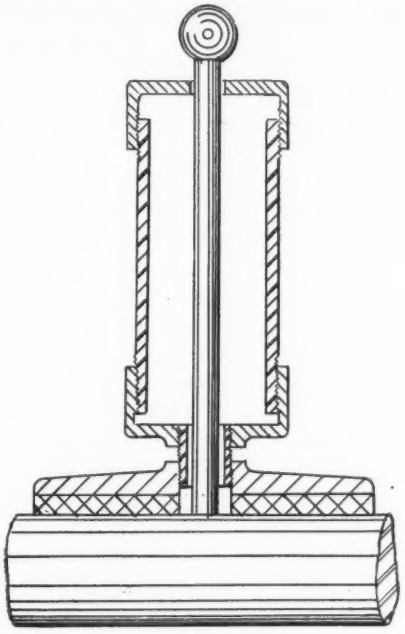
Oh yes, Bill's looking gloomy, and I think that look of gloom
Will stay upon his countenance 'till he goes to his tomb.
He'll have to move from these parts, for no one will give him work,
They'd rather hire the devil now than hire that bloody Turk.
Of course, Bill's an exception. In the engineering trade
I've met lots of noble fellows—the best friends I've ever made;
But sometimes, as in all trades, a hot-head will appear,
And by his actions stain the noble name of engineer.

Detroit, Mich. J. J. H.

A Home-Made Grease Cup.

EDITOR THE PRACTICAL ENGINEER:

For an extra precaution for bearings which require much attention and are located in out-of-the-way places, a very good grease cup is made as follows: Take a 1½" nipple of any convenient length, say 4 inches. Screw a cap on each end with a



A Home-Made Grease Cup.

½" nipple on the cap leading to the bearing and a hole in the top cap for the brass rod to pass through, as shown in sketch. The friction between the shaft and rod heats the rod enough to allow the grease to follow down the rod, thus lubricating the bearing.

Brooklyn, N. Y. J. G. S.

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Rodney's Troubles.
Or Do We Need a License Law in Michigan?

(Eighth Letter.)

i got ure lettur, mr. editur, whur u explane tu me as how i wuz rite about thu kontrakshun and eckspanshun and i jist made henry own up thet he wus beet. he sed he node he wus fur he askd the cheef uv the nu power hous about it and he told him jist the saim as u did to me. i want tu ask u a kwestune about a steem injine. whur is a eckspanshun kurv on a steem injine? and anuther thing iwood lik tu no. i heerd the cheef uv the power hous tellin a fellar somthin about the enishel preshur ov a injine, so i wus looken on mi injine fur it and i found, on a bras plait on the biler steem pressure not to exceed 100 pounds per sq. inch. haint thet the enishel preshur. thear is sum moar enishels on the plait besids that fur in the bottum corner uv the plait it is marked U. S. A. & Co. and 1879. so i think i haint got mutch trubble tu find the enishel preshur tu mi thrasher injine

i tuk mi injine and biler ovur tu Meels gris mill dam last fridy tu driv sum spiles with Anvul Hogans drivur. we got neer all the spiles druv, when rite aftur dinnur az i wus startun up the injine, thur wus an awful suddun pound and all at wonst the steem wus bloen out ov the hind end of the silendur, and u kin bet i wus skart. jist then sumthin els hapend that wus a big supprize tu me. the biler especter jist kum up in time and he stoped the steem from doin any harm. a strang thing about thet especter, he allus happuns around jist in the nik o time. he sed he cum to se if I had a soft plug in my masheen and i told him thet i had and if he wanted tu se it ide sho him, but i gess he seen it himself fur enny 1 kud se it fur i had it in evur sence sum buddy stoal the irun 1 whut lets the wattur out ov the pipes whur the disaust steem gose thru tu warm the fead wattur fur the biler. this soft plug i taik out at nite when i put up the masheen so thear kan be no dangur.

well when i got stratend around agin and luked at the silendur i found that mi masheen wus neerly dun fur. but the espectur sed thet it kud sune be fixd bi a masheenist. so him and henry druv to town and fetsched a man with them tu du the job. i asked the espectur whut kaused the hed tu brake and he sed kondensd steem, i askd the masheenist whut he thot kaused it tu brake and he sed wattur in thu silendur, now mr editur which 1 ov them fellers am i to believe. it pussels me verri mutch fur i heerd thu fellar in thu gris mill saen to henry thet a hi preshur injine iz not a kondensen injine, and i think thet mebby when mi preshur injine got to kondensen it wus goen rong. pleeze let me no sumthen about this bisnus so i can get along with out so mutch trubble.

rodney gumkirk

orkners Corners.
in cair mi dad. Munrow Kountee Meechigan.

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Rule to Determine the Temperature of Saturated Steam When the Gauge Pressure is Known.

EDITOR THE PRACTICAL ENGINEER:

A very useful rule for determining the temperature of saturated steam when the gauge pressure is known is as follows:

At 40 pounds pressure, the temperature of saturated steam is 287 degrees.

From 40 to 60 pounds, add 1 degree for each pound of steam pressure, making the steam temperature at 60 pounds, 307 degrees.

From 60 to 80 pounds, add 0.8 degree to each pound of steam pressure, the steam temperature at 80 pounds being 324 degrees.

From 80 to 100 pounds, add 0.7 degree for each pound of steam pressure until 100 pounds is reached, the steam temperature for that pressure being 338 degrees.

From 100 to 130 pounds, add 0.6 degree for each pound pressure until 130 pounds is reached, the temperature at that pressure being 356 degrees.

From 130 to 160 pounds, add 0.5 degree for each pound pressure until 160 pounds is reached, the temperature of steam at 160 pounds being 371 degrees.

From 160 to 185 pounds, add 0.4 degree for each additional pound pressure, the temperature of steam at 185 pounds being 382 degrees.

From 185 to 215 pounds, add 0.4 degree for each pound of steam, the temperature at 215 pounds being 394 degrees.

From 215 to 275 pounds, add 0.3 degree for each pound of steam, the temperature at 225 being 397 degrees, at 250 pounds 406 degrees.

Cambridge, Mass. W. A. D.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

EDITOR THE PRACTICAL ENGINEER:

Please answer the following questions:

(1). What is the weight of water in a 12-inch column?

(2). Give rule for finding the horse power of any size boiler.

(3). How would you stop a boiler from foaming and still keep it running?

(4). What would you do preparatory to shutting down a plant and what would you do in starting one up that had been shut down for a length of time?

Mt. Orab, Ohio. G. W. G.

(1). Assuming the area of the water column to be one square inch, the cubical contents of the column will be 12 cubic inches. As a cubic inch of water weighs .0361 pounds, the weight of water is $.0361 \times 12 = 0.4332$ pounds. The pressure per square inch at the bottom of the column due to a head of 12 inches is also 0.4332 pounds.

(2). The only accurate way for determining the horse power of a boiler is to make a test of its evaporative abilities. This can be done by measuring the feed water consumed during a certain period of time. If the temperature of the feed water be known and the quality and pressure of the resultant steam obtained, the horse power can be calculated. Suppose a boiler evaporates 6000 pounds of water in one hour from a feed water temperature of 120 degrees, into steam at a temperature of 327 degrees, the quality of the steam being found by a calorimeter to be 97 per cent. The heat in one pound of steam is then $(327 - 120) + .97 \times 884$, in which 844 is the latent heat of evaporation. This is equal to $(207 + 857) = 1064$ heat units. As a horse power according to the usual rating is the equivalent of 33,305 heat units transferred per hour, the horse power of the given boiler can be obtained by multiplying the amount of water evaporated per hour by the heat units given to each pound and dividing by the factor 33,305, which gives $6000 \times 1064 \div 33{,}305 = 191$ horse power.

(3). Foaming in a boiler is usually due to some impurities in the feed water such as oil, salts of sodium, etc. If possible, when this occurs, change the kind of feed water that is being used or, at least, try changing the water in the boiler by putting on a strong feed and blowing out at short intervals. It might become necessary to check the outflow of steam, which will usually stop it, by throwing off the load. Violent foaming can be checked by opening the furnace door, closing the damper, and covering the fire with fresh coal. This means of relief should be used as little as possible, because it has a tendency to injure the boiler owing to the sudden contraction of the parts exposed to the fire.

(4). When a boiler is not to be used for some time, it is either emptied and dried, or it is left full of water with a quantity of common washing soda. External parts exposed to dampness are coated with linseed oil. When the boiler is started, it should be filled with clean water to the proper level, being sure to test the gauge cocks and safety valve before starting. In starting a fresh fire under the boiler, allow it to burn very slowly at first in order to bring all the parts of the boiler to an even temperature. When leaving an engine for any length of time, it is best to remove the cylinder head and take out the piston with its rod attached by detaching it at the crosshead. All parts of the engine, especially the bright and working parts, should be covered with heavy oil or vaseline to prevent rusting and all parts should be carefully covered with some form of covering, as canvas, to prevent dust from accumulating. All valves should be oiled whenever possible and left open or off their seats. All auxiliary devices should be treated in the same manner whenever possible, the object always being to prevent working surfaces from rusting or sticking together. Before starting up a plant that has been idle for some time, of course, all these parts should be replaced after being thoroughly cleaned, new gaskets and packings put in to be sure of no breakdown after starting. All drips should be left open and everything started as slowly as possible. The valves should always be "cracked" for some time before allowing full pressure to flow through them. A surplus of oil on all the moving parts will be a preventive against overheating when starting. All belts which are left loose before shutting down should be tightened gradually.

In starting up a dynamo, the oil rings should revolve freely and draw up a liberal amount of oil to the top of the shaft. If the commutator or collector rings are not clean, they should be carefully wiped, and if necessary polished with very fine sand paper while the machine is in motion and before the brushes are lowered in position. After polishing, a small amount of vaseline may be applied with a cloth. Before throwing on the full load, it is advisable to run the machine very lightly loaded for some time in order to dry out any moisture that may be present. These are a few necessary precautions which should be taken, others suggesting themselves to the engineer of the plant when on the ground.—[Ed.]

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EDITOR THE PRACTICAL ENGINEER:

Will you kindly explain why a locomotive could not be made to a wider gauge? Has friction anything to do with it? What prevents locomotives from being made longer and how do you figure out the weight of the engine that will fall on the trucks?

Portland, Ore. J. T. McS.

A locomotive can be made wider or narrower, longer or shorter, depending upon the humor of the designer. Long practice, however, has indicated that it is preferable to have certain dimensions. The size of the boiler is proportioned to the amount of adhesive weight and to the speed at which the locomotive is intended to work. A locomotive with a great deal of weight on the driving wheels could pull a heavier load and would therefore have a greater cylinder capacity than one with little adhesive weight. An engine of this type would consume more steam and consequently have a larger boiler

The method for figuring out the weight of a locomotive that will fall on the trucks varies with the different types and styles. For Mogul engines, the total weight on the drivers is multiplied by 0.2 and the product is the weight on the trucks. For ten wheel engines, the total weight on the drivers multiplied by 0.32 will be equal to the weight on the truck. For Consolidation engines, the total weight on the drivers multiplied by 0.16 will give the weight on the truck and the weight on the truck of an eight wheel engine is about one-half of that placed on the drivers. The sum of the weight on the trucks plus the weight on the drivers is in each case the total weight of the engine.

The eight wheel type of engine has four coupled driving wheels and a four wheel truck in front. The ten wheel type has six coupled driving wheels and a four wheel truck in front. The Mogul freight type has six coupled driving wheels and a pony or two wheel truck in front and the Consolidation engines have eight coupled driving wheels and a pony truck in front. Besides these there are dozens of other different styles and types used for different purposes.

Locomotives can be built to any gauge desired within certain limits but are usually built to the same standard for convenience.—[Ed.]

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EDITOR THE PRACTICAL ENGINEER:

Will you kindly give me receipt for cleaning old Britannia ware that is badly tarnished? I have tried a number of different acids and it is impossible to get it off with emery cloth.

Ithaca, N. Y. A. L. P.

Britannia metal, which is a mixture of about 86 per cent. tin, 11 per cent. antimony, 2 per cent. zinc and 1 per cent. copper, is said to be well cleaned by dipping the article in a mixture of 1 part of nitric acid and ½ part of sulphuric acid, then rinse with water and rub with sawdust. If the article is greasy, dip it first in a boiling hot solution of potash lye.—[Ed.]

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EDITOR THE PRACTICAL ENGINEER:

Will you kindly give me the following information through the columns of your valuable paper? I have three sets of taps and dies and a master tap to each set. The dies are worn out, so I am going to try to make three new sets. Kindly instruct me how to use the master tap.

Esquimalt, B. C. F. N. J.

A master tap is used as a standard to standardize threads that are cut by the dies or, as in this case, to standardize the dies themselves. In making the new dies, since there are three dies to each set, they would be first turnd up on a lathe to the correct pitch, and by introducing the master tap, it can be seen if the thread is being cut correctly either in the first, second or finishing die. When the finishing die is completed, the master tap should exactly fit it both with respect to pitch, diameter and profile of the threads. These things being correct, the dies are hardened, which makes them ready for use. —[Ed.]

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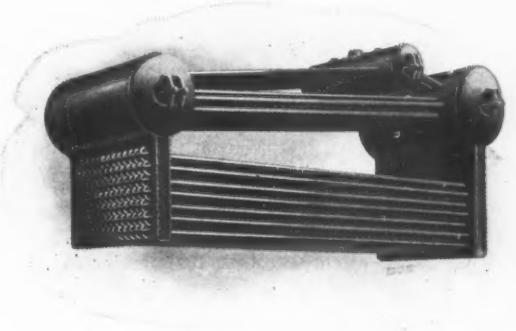
Germantown Council's Second Anniversary.

The second anniversary of Germantown Council, A. O. S. E., which occurred Saturday, April 30th, was delightfully celebrated with a banquet and dance at Mosebach's Hall, Broad and Columbia Ave. About 75 couples were present and all enjoyed themselves thoroughly.

A New Horizontal Water Tube Boiler.

A new water tube boiler has been placed on the market by the Atlas Engine Works, of Indianapolis, in which many of the difficulties previously experienced with this type of boiler have been practically eliminated. The boiler purifies its own feed water, superheats its steam and provides for a practically unimpeded circulation. The boiler is of the horizontal type, having two water legs and three steam drums which run across the boiler. The rear and front drums are made of continuations of the same plates that form the rear and front water legs, a method of construction that prevents any seam of any kind from being exposed to the flames or hot gases. The legs open into these drums the full length of both the legs and the drum, thus avoiding any contraction at the throat, which impedes circulation and which has been one of the inherent faults of this type of boiler.

In the rear drum is located a live steam purifier, independent of the drum and so arranged that it can be blown out at any time without interfering with the operation of the boiler. The generating tubes between the water legs are set on a slight incline and each is commanded by a separate handhole at

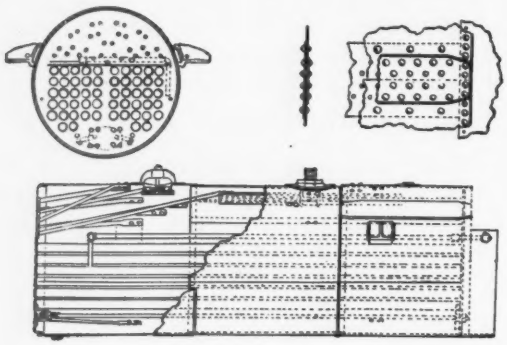


each end. Equalizing tubes between the front and rear drums help to perfect the circulation and keep an equal water level in both of these drums. Superheating tubes entering these drums above the water line carry the steam to the middle or steam drum, whence it is piped for use. The boiler is built in sizes ranging from 100 horse power up and can be erected and shipped as a whole, or in sections, in which latter case all the riveting is done at the shops and the tubes are expanded into the legs and drums after arrival.

The points of advantage claimed for this design are numerous. Not only dry, but superheated steam is assured, making it impossible to throw water into a cylinder or give wet steam. The purification of the water gives long life to the boiler and requires less fuel and labor. The facilities for cleaning are unsurpassed. Ample manholes give access to the drums and all the tubes carrying water are straight and readily accessible. The superheating tubes, carrying steam only, are slightly curved to take care of the expansion. By getting all seams away from the fire and hot gases, the possibility of leaks at the rivets or plates cracking from the rivet holes to the edge is eliminated. The masonry required is simple and comparatively inexpensive, consisting of straight side walls and bridge walls, with no overhanging walls between or to the drums. Materials and workmanship throughout are the best.

The Atlas has also added to its standard line of tubular boilers a new boiler of the triple riveted butt-strap construc-

tion for a constant working pressure of 125 pounds, to supply the demand for a boiler of intermediate pressure. It is built in seven convenient sizes, ranging from 48″ x 14′, rated at 50 horse power to 72″ x 18′, rated at 150 horse power. The size, number and arrangement of the tubes is such as to insure

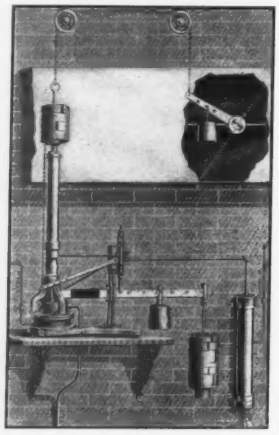


good draft and excellent circulation. Details of riveting and bracing are fully shown by the line drawing. The boiler throughout carries the Atlas mark of high-grade materials and workmanship.

The Locke Damper Regulator.

The accompanying cut illustrates the well-known Locke Damper Regulator which has been on the market for the past 18 years for the purpose of regulating the damper so that a constant steam pressure will be maintained on the boiler. It is automatic in every respect and when once set up in operation, it requires no attention other than an occasional oiling and cleaning.

The entire system of weights and steam pressure is in constant equilibrium, so that if there is any change in the steam pressure, the weights will so adjust themselves as to regulate the damper as follows: If the steam pressure increases just enough to overcome the weights on the lever, and open the valve, water is admitted to the piston, which raises it and al-



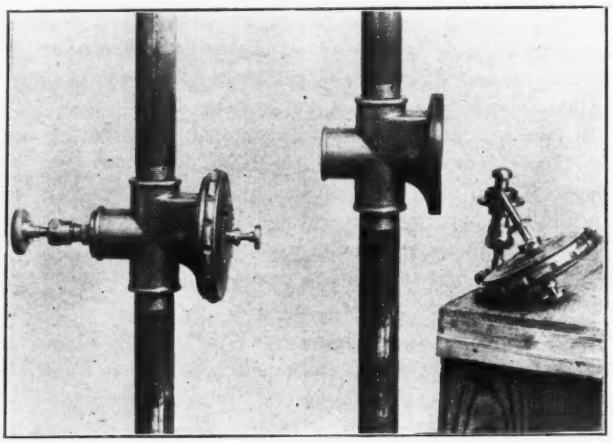
lows the damper to close sufficiently to check the fire. If, on the other hand, the steam pressure falls off, the lever falls at the same time, allowing the piston to fall and open the damper and increasing the fire. If properly adjusted, the regulator should keep the variation in steam pressure within one pound.

In the many years that it has been in service, there has been only one change that it has been advisable to make in the regulator and that is, the substitution of a water reservoir 3 inches in diameter and 3 feet long to take the place of the coil of pipe which was put in the older machine. The advantage of this is that it can be placed in the same position with the regulator rather than at some distance from it, the function of each arrangement being the same, that of condensing the steam so that it prevents any liquid of high temperature from coming into contact with any of the moving parts of the apparatus.

This machine will be sent on 30 days' trial to any persons interested, and if not satisfactory, can be returned. The distributing agents of this machine are the well-known firm of Wm. E. Benson and Co., 1001 Chestnut St., Phila.

The Dunham Low-Pressure Trap.

A steam trap built expressly for low pressure heating as well as oil separators is made by the C. A. Dunham Co., of Marshalltown, Iowa. The chief feature of this trap is that it will work successfully under varying conditions and pressures and without attention. Heretofore, an expansion steam trap set



and adjusted to discharge from a higher pressure into a vacuum would require readjustments in the event of any change in these conditions, but in the Dunham low pressure trap this has been eliminated.

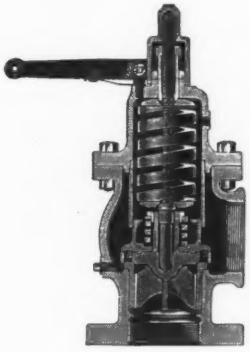
The accompanying illustration shows the trap in position on the pipe line and also the trap with the valve and by-pass removed. The manner of getting at the different parts is clearly shown. The St. Louis Exposition have a number of these in use on their power plant service as well as several of the high-pressure type made by the same Company.

Crane Patent Encased Spring Pop Safety Valve.

The construction of these valves embodies a self-adjusting feature which automatically regulates the "pop" of the valve; that is, it maintains the smallest possible waste of steam between the opening and closing points, which means there is no necessity for re-adjusting to regulate the "pop" on changes in the set pressure.

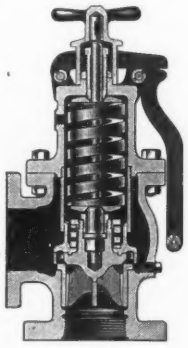
In all Pop Safety Valves it is necessary to have a "pop" or huddling chamber into which the steam expands when the main valve opens, thereby creating an additional lifting force

proportional to this increased area, which, being greater than the force of the spring, holds the valve open until the pressure is relieved. Means must be provided to relieve this "pop" chamber of pressure in order to allow the valve to close promptly and easily.



This is accomplished in the Crane Valve by the self-adjusting auxiliary valve and spring, which are entirely independent of the main valve and spring. These operate as follows: The steam in the "pop" chamber finds a passage through holes or ports in an annular space provided in the auxiliary valve or disc, and by reason of the light auxiliary spring, this pressure lifts the auxiliary valve and allows the steam in the "pop" chamber to gradually escape, thus permitting a great range in the setting pressure with the least waste of steam and at the same time supplying a cushion or balancing medium, thereby preventing any chattering or hammering and affording the easiest possible action in closing. It is due to this feature that in changing set pressures within reasonable limits of the spring capacity, nothing further is to be done but simply, for a higher or lower pressure, turn down or out on the screw pressure plug at the top of the valve.

The encased spring valves are constructed with a casing or chamber enclosing both springs, protecting them against the action of the steam, which, blowing with great force and velocity throughout all parts of the valve before reaching the atmosphere, would otherwise have a tendency to disarrange the springs and other parts operating in connection therewith. This form of valve is useful where a number of valves may



be connected to one main exhaust or discharge pipe, as the encased spring chamber extending over a greater portion of the top surface of the main valve, prevents any retarding action of the steam due to back pressure which might be caused by one or more valves opening slightly in advance of another.

These valves are built to conform with all the rules and regulations of the U. S. Steamboat Inspection service and Inspectors of Steam Vessels, on the basis of one square inch have been approved by the United States Board of Supervising of valve area to three square feet of grate surface and on water tube, coil, or sectional boilers, carrying pressure exceeding 175 lbs. on the basis of one square inch of valve area to six square feet of grate surface.

They have bevel seats at an angle of 45 degrees from their centre line of axis, and are made of composition or with solid nickel bushings as may be required. The cam lever is capable of lifting the valve off its seat one-eighth the diameter of the valve opening whether or not there is pressure on the boiler and may also be thrown over far enough to lock the valve open should occasion require it or it is desired to blow off all or a portion of the steam from the boiler through the safety valve. The cap is made with handles or cross bars and fastened to the stem by a key pin. The stem in turn is securely attached to the main or wing valve and having a square section operating in a square socket or recess in the main valve which affords means of turning the valve on its seat, thereby removing any incrustation that may accumulate.

The valves can be taken apart without removal from boiler and without disturbing the outlet pipe and are suitable for pressures up to 250 pounds. They are manufactured by Crane and Co., who have also brought out a number of improved forms of pop valves for stationary, marine, locomotive and portable boilers and also a variety of cylinder, water, high pressure and hydraulic relief valves for all purposes and pressures.

Employes of Norristown Covering Co. Banqueted.

The story of the growth of the Norristown Covering Co., of the harmony always existent between employers and employes, and of the ever-increasing interest of the employes in the advancement of the firm, was admirably told in pleasing after-dinner speeches at a banquet tendered the employes by the management of the Company, on Monday evening, May 9th. The object of the affair was to more firmly establish the bond of fellowship between the Company and the men, and it was a complete success. Superintendent Charles Platt officiated as toastmaster. There were some good speeches, songs and recitations. Mr. Platt was presented with a massive floral tribute, the gift of the office force. The growth of this concern during the past five years has been enormous. Mr. Platt attributes this success to the merit of their coverings and to judicious advertising.

We Wonder When.

It has been estimated that about 250 times as much light might be obtained from a watt than at present, if it were known how to convert it. About 10 times as many watts might be obtained from the coal as are at present obtained from the steam engine, if it were only known how to do it. By combining both of these possibilities it may be that at some time in the future, 2500 candle power may be obtained from the same amount of coal now used to produce one candle power.

The Allentown Convention of the A. O. S. E.

As the years roll round and the Annual Conventions of the American Order of Steam Engineers come and go, with their wealth of pleasure, good-fellowship and valuable instruction, the regular attendant learns to better appreciate the manifold advantages of co-operation among engineers, and to realize the many opportunities for doing good that are open to such organizations.

The 18th Annual Convention of the Supreme Council, A. O. S. E., which was held at Allentown, Pa., on the 9th, 10th, and 11th of May, possessed all the good and desirable qualities of other conventions that have preceded it, and perhaps some new ones, though as a matter of fact it was in all essential respects very similar. Therefore this attempt at describing it with a pencil seems much like getting down last summer's straw hat. True, this sameness cannot be called an objection, for perhaps, after all, it is the sameness that makes conventions a hobby with many of us.

If most of us were to follow our inclinations we would wear last summer's hat in preference to a new one because it would be more comfortable, and it is probable that this sameness at conventions is what produces the greatest amount of comfort, good-fellowship and genuine pleasure.

Meeting the same good fellows year after year; the same cordial greetings; discussion of many of the same old subjects, listening to many of the same old stories and perhaps to the same old songs; three or four pleasant days together and then the "goodbye until next year" leaves lasting and beneficial impressions.

All engineers do not make good organization men, but that is chiefly because they do not "dig deep enough" to reach and enjoy the good; if they did, the membership of all engineers' societies would be greatly increased and the profession of steam engineering would be elevated to a higher plane.

The Allentown Convention was opened on Monday morning, May 9th, in the hall occupied by Lehigh Council. A. P. Dreisbach, Chairman of the Entertainment Committee, presided, introducing Mayor Lewis, who made a rousing speech of welcome which seemed to please the delegates greatly and they applauded heartily. Supreme Chief Noah R. Pierson responded, after which the Council went into a business session.

At the afternoon session a communication from the Business Men's League of Milwaukee was presented, inviting the Order to hold their next convention in that city. An invitation was also presented by the Philadelphia delegates and it was finally decided to hold the next convention in the Quaker City.

Monday evening a reception was given to the business men and local engineers in a separate hall in the same building, where numerous steam specialties and engineers' supplies were on exhibition.

The principal event at the Tuesday morning session was the election of officers, which resulted as follows: Supreme Chief Engineer, Hiram G. Trout, Reading; First Assistant, W. S. Price, Atlantic City; Recording Secretary, Charles W. Leng, Philadelphia; Corresponding Secretary, J. H. Stallings, Baltimore; Treasurer, George W. Richardson, Philadelphia; Chaplain, A. P. Dreisbach, Allentown; Senior Master Mechanic, James K. Holland, Philadelphia; Junior Master Mechanic, Joseph T. Harris, Milwaukee, Wis.; Inside Sentinel, F. J. Armbruster, Philadelphia; Outside Sentinel, C. H. Pfeffer, Camden; Trustee for three years, J. C. McDowell, Philadelphia. The hold over trustees are C. P. Williams, Philadelphia; W. J. Mitchell, Wilmington, Del. The revision of the constitution and by-laws occupied the attention of the members during the remainder of the morning session.

Tuesday afternoon the delegates were the guests of the Atlas Cement Co., at Northampton, about five miles north of Allentown, to which place they were taken on special trolley cars. At the works they were met by Superintendent Seaman and Chief Engineer H. T. Raisbeck, who escorted them through the immense plant, the buildings of which cover more than fifteen acres of ground. Sixty engineers are employed in the plant, working three shifts of eight hours each.

Tuesday evening a grand banquet was served in the dining rooms of the Hotel Allen. Two hundred and sixty-seven guests gathered about the handsomely decorated tables and enjoyed the following excellent menu, which was faultlessly served:

MENU.

Iced Little Neck Clams.

Sherry.

Radishes. Lettuce.

Sliced Tomatoes. Olives.

Consomme.

Planked Shad. Potatoes Julienne.

Hotel Allen Salad.

Rhine Wine.

Sweetbreads with Mushrooms.

Green Peas.

Roast Young Turkey. Giblet Sauce.

Bermuda and Sweet Potatoes.

Salad.

Champagne.

Strawberries. Neapolitan Cream.

Cakes.

Roquefort Cheese. Crackers.

Coffee.

Cigars. *Cigarettes.*

The service was a distinct credit to mine host, Col. Harris. A local paper described it as "one of the largest and certainly the merriest affair ever held in the dining halls of the city's leading hotel." Surely a more enjoyable affair has never occurred at a convention of the A. O. S. E. There was much to make it pleasant, for in addition to the appetizing menu, the perfect service and excellent music, there were present a large number of ladies,—handsome ones too, for which Allentown is famous.

When the menu was exhausted and everyone was filled with good things and contentment, Supreme Chief Noah R. Pierson made a brief speech, reviewing the present condition and future prospects of the Order, and concluding with the presentation on behalf of the delegates, of a handsome writing desk to A. P. Dreisbach, Chairman of the Entertainment Committee. Mr. Dreisbach responded and was heartily cheered; indeed, he proved a great favorite with the delegates throughout the convention.

The newly-elected Supreme Chief Hiram Trout then spoke, briefly expressing his appreciation of the honor conferred upon him and urged the co-operation of all members of the Order. Then John W. Armour was introduced and he told

good stories and sang some good songs, all in his own delightful way, convulsing his hearers with laughter until the evening was no more.

At the Wednesday morning session the new officers were installed by Past Supreme Chief James Lightfoot, assisted by Past Supreme Chief Franklin R. Moore. At two o'clock in the afternoon an open meeting was held which President P. H. Hogan, of the National Association of Stationary Engineers, had been invited to address. Mr. Hogan quoted extracts from the Constitutions of both the A. O. S. E. and the N. A. S. E. and reviewed the remarkable similarity between the two Orders. He spoke eloquently of the important work that is being accomplished by both organizations and suggested that united effort would doubtless result in much greater good. Altogether it was a most excellent speech and was heartily applauded.

Hiram G. Trout.
Supreme Chief Engineer, American Order of Steam Engineers.

Mr. Herbert E. Stone, Past President of the N. A. S. E., was the next speaker. Mr. Stone made one of his characteristic speeches, putting everybody in a good humor and winding up by complimenting the Entertainment Committee very highly and promising to be a regular attendant at Conventions for the next fifty or sixty years.

The Convention then went into executive session and wound up the business of the meeting, adjourning at 3.30 P. M. to meet again in Philadelphia on the second Monday in May, 1905.

The Supply Men.

There were about thirty supply men in attendance at the Allentown Convention and they were a jolly lot. Some had brought new specialties and others stood by the "old reliable," but all had a stock of new stories and amusing tricks.

A large hall in the same building where the Convention was held had been specially fitted up for the supply men and a dozen or more of them had a very complete line of samples on exhibition. Among the latter were the Collins Manufacturing Co., of Conshohocken, Pa.; Keiley & Mueler, of New York, and E. F. Houghton & Co., Philadelphia. Sayen & Shultz, 13th and Commerce Sts., Phila., showed a most complete line of packings and mechanical rubber goods. Their "Mercer" brand black sheet, oil-proof packing attracted much attention and many favorable comments. The H. W. Johns-Manville Co., of 106 William St., New York, showed a large display of "Kearsarge" flange joint gaskets. These gaskets are made from high-grade asbestos-metallic cloth and saturated with a special heat resisting compound. It is claimed that they will hold against any pressure and that they are not affected by heat or chemicals.

The Keystone Lubricating Co., of Philadelphia, had an extensive exhibit of Keystone Grease of which they were presenting sample cans to the delegates. This exhibit was in charge of Chas. A. Hopper, their popular Philadelphia representative.

John R. Livezey, of Philadelphia, showed a most thorough and complete line of samples of Nonpareil Cork for pipe coverings, cork flooring, cold storage insulation and a variety of other uses. He also showed a line of high-grade magnesia coverings, all of which was looked after by Mr. Thos. Brannen. Mr. Brannen is a heavy-weight in the pipe covering business but he never lost an opportunity to tell about the lightness of cork and its wonderful insulating properties. Mr. Livezey was also in attendance, smiling and happy as usual. Mr. Livezey is a decided favorite at the A. O. S. E. Conventions, not having missed one in many years.

The Allentown Reed Harness and Mill Supply Co. had a really handsome exhibit of injectors, lubricators, valves and all sorts of engineers' brass goods.

Another attractive exhibit was that of the Crescent Manufacturing Co., of Scottdale, Pa. This exhibit consisted of Lackawanna lubricators, oil and grease cups, etc.

L. B. Walters, of Chester, Pa., showed a number of handsome models of the Eureka Steam Trap.

Mr. Heisler, of the Central Machine Co., Philadelphia, displayed a Copes Automatic Boiler Feed and House Tank Regulator.

Mr. Chas. H. Heger exhibited the Anderson Steam Trap manufactured by The V. D. Anderson Co., Cleveland, O.

The Norristown Covering Co., of Norristown, Pa., showed a most thorough and complete line of pipe coverings for every variety of service. One feature of this exhibit which attracted more than passing attention was a handsome oak frame with glass face and deep back, in which were many samples of coverings, all handsomely arranged and making a very pretty effect. Mr. Stokes looked after this exhibit and made many friends among the delegates.

John T. Lindstrom, of Allentown, displayed several Lindstrom steam and oil separators and also a new steam trap in which the float operates a valve of the Corliss type. This latter proved a decided novelty and was looked upon with much favor.

Decidedly the most interesting exhibit of the lot was that of the Dearborn Drug and Chemical Works, of Chicago. It consisted of a sign on the wall, a table, an ever-present box of good cigars, a small blank book and a chair. It's almost a shame to tell it, but that modest looking exhibit caused more trouble than all the others. The book purported to be a register in which each new "come on" was requested to place his auto-

graph. The trick was in the chair, and the man in charge, Duemler—Frank G.—you all know him—was no respecter of persons. Just when the victim was trying to remember his home address and was confused over Duemler's instructions to

Mayor Fred. Lewis.
Who made the Speech of Welcome.

"write it on the next page," down went the chair and a 32-calibre cartridge exploded at the same time. Then the crowd yelled with delight. Everybody got caught, even Sam Anness and Billy Le Compte. Speaking of Le Compte recalls another Satanic product: Le Compte represents Jenkins Bros., resides in Baltimore and survived the fire,—we don't know why. He was at Allentown and had a great supply of other souvenirs with him, including a lot of copper pennies badly damaged by the fire and many of them brazed together. Le Compte said they were taken from the ruins of the Equitable Building. Someone else suggested that he had probably utilized the fire under some friendly engineer's boilers. In any case, Le Compte has a reputation for burning money. He was in charge of Jenkins Bros.' exhibit—the prettiest booth in the hall, from which his chief delight was to hand out Baltimore relics. He advertised "the only thing that did not burn." It proved to be an ordinary red brick. Again he advertised the only thing "saved" from the fire. Those who inquired were shown a Jenkins Globe Valve, and told that it was so valuable that the people saved it and let the city burn.

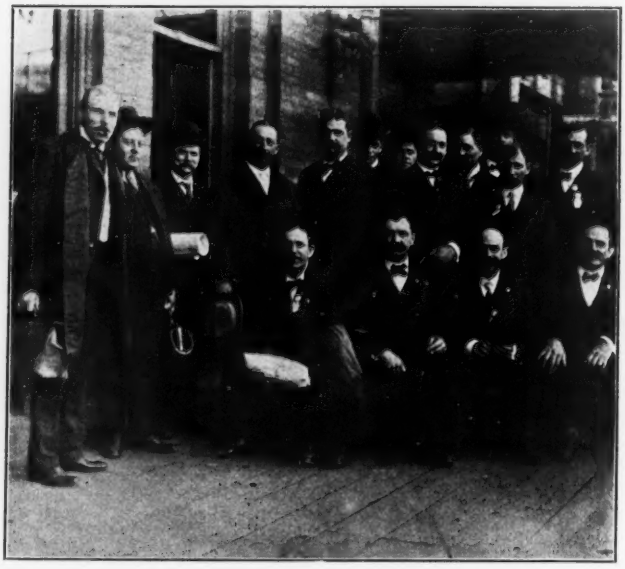
In addition to the exhibitors there were a number of drummers who just came to show their faces, not that their faces were for sale, for it was not a good market for brass goods. What we mean to say is, that they brought no samples of the product of their firms but were there solely to enjoy themselves and to help make things pleasant for their engineer friends. There was jolly Al. Burns, of the Barr Pump Co., Philadelphia; Billy Milligan, Philadelphia's leading high-pressure steam fitter; and G. E. Tanberg, representing Libby Manufacturing Co., New York. Tanberg was formerly an engineer in Wisconsin and it was interesting to see the way he warmed up to Joe Harris, the Wisconsin delegate. It must have seemed like getting a letter from home. In any case, Tanberg is a good fellow and with the swell line of goods that he is now handling, he should soon be able to visit his old home in an "auto."

The Geo. W. Lord Co., manufacturers of the well-known Lord's Boiler Compounds were ably represented by Captain Doughty and Mr. Phillips. The Captain was the only man who needed no introductions. Twenty years on the road have given him a very large acquaintance and his sunny disposition has made him a favorite with all.

The Keystone Chemical Co. were represented by Mr. Bray; Thos. C. Warley & Co., manufacturers of Warley's Boiler Compounds, was represented by Mr. Warley, who is one of the oldest members of the A. O. S. E. and too well-known to need extended mention. "Power" was represented by Vogel, Fred Low and Jack Armour; Herbert E. Stone represented the Chapman Valve Co., while Pedrick and Megarvey did stunts in the interest of H. B. Underwood & Co., and gave away trick match safes as souvenirs.

Another souvenir which was greatly appreciated was a neat little watch charm in the shape of a perfect little monkey wrench, which was given out by Mr. J. C. McNelley, the popular manufacturer of McNelley American Boiler Compound.

The Garlock Packing Co. were represented by Mr. Barnes and Mr. Lyon. Mr. Barnes lives in Allentown and he was determined that the Convention should be a credit to the city.



Kodak Picture of a Group of Delegates and Visitors to the A. O. S. E. Convention at Allentown, Pa.

Reading from left to right ;—1, Percy Kley. 2, Thos. Brannen. 3, Jos. Gillespie. 4, Chas. A. Hopper. 5, Joseph Calloway. 6, W. J. Mitchell, Supreme Trustee, A. O. S. E. 7, Fred W. Moore, Past Supreme Chief, A O. S. E. 8, seated in centre, P. H. Hogan. 9, H. R. Taliaferra. 10, Sam Magarvey. 11, W. J. Eccles. 12, Herbert E. Stone, Past President, N. A. S. E. 13, E. H. Naylor. 14, Samuel Logan. 15, J. T. Harris, 16, G. F. Duemler.

He worked like a trojan and the assistance that he rendered Chairman Dreisbach was invaluable.

Harry Young, chief engineer of the Fryden Horse Shoe Works, at Catasauqua, gave out small aluminum horse shoes as souvenirs, while just to prove that horse shoes are lucky, Mr. Roberts, the superintendent of the Works won a gold watch that was chanced off.

TRADE NOTES

The Lagonda Manufacturing Co., Springfield, Ohio, have received a letter under date of May 3rd, 1904, from James E. Fitts, of the C. E. Wamsutta Mills, New Bedford, Mass., as follows:

Dear Sirs: The Turbine Tube Cleaner that we bought of you in February, we have used every day since, cleaning our Economizer Tubes, and find that it works just as well at present as when new. We have not worn out one set of cutters and have never found a machine that did better work.

The Norristown Covering Co., Norristown, Pa., manufacture steam pipe and boiler coverings for every kind of service and for all pressures. Readers of the "The Practical Engineer" who have boilers, pipe, heaters or tanks that are without insulation, should write the Company for estimates of the cost of covering same. The covering will pay for itself in a short time, and moreover, summer is the time to attend to such matters.

A steam trap with a Corliss valve is a novelty, to say the least. The advantage is obvious. John T. Lindstrom, of Allentown, Pa., is the inventor. Write him for further details.

O. F. Zurn Co., the well-known manufacturers of high-grade lubricating oils, have removed their offices to 23 and 25 South Fifth St., Philadelphia, where they will have larger and more elaborate quarters. The new offices are right next to the Bourse. This move was made necessary by the enormous increase in their business during the past year or so. This is as it should be for there has probably never been a more popular oil house in Philadelphia.

Frank A. Simonds, 421 Houseman Building, Grand Rapids, Michigan, has received the following interesting letter:

Grand Rapids, Mich., Jan. 7th, '04.

Mr. Frank A. Simonds, City.

Dear Sir: With this we hand you check covering your invoice of December 26th for "Receiver and Separator" installed upon our engine, December 23rd and 24th.

While handing you this check, we cannot refrain from mentioning our satisfaction with the device. It relieves our battery of boilers from the objectionable vibration caused by the action of the engine and maintains a pressure upon the cylinder nearly uniform. We deem this improvement alone as fully compensating us for the cost of the device and would say we are especially pleased with its action in every respect.

Yours respectfully,
The Widdicomb Furniture Co.,
Wm. Widdicomb, Pres.

The "P. B. H." Quick Closing Water Gauge is a mighty handy thing to have on your boilers; a pull of the chain from the floor does the trick. It's especially handy when the glass breaks. If your boilers are not already equipped with them, write for circular to Paul B. Huyette, 1245 Betz Building, Philadelphia.

Engineers who are troubled with wet steam, or water lifting over and endangering the cylinder should investigate the merits of Compound Separators, manufactured by the Kutztown Foundry and Machine Co., Kutztown, Pa.

The Keystone Lubricating Co., 20th and Allegheny Ave., Philadelphia, have issued a neat little booklet telling the advantages of grease as a lubricant. Copies will be mailed to anyone interested, or if any of our readers wish to give the grease a trial, the Company will send a sample can and a brass grease cup to any engineer or steam user, free of charge, express prepaid.

The France Packing Co., 6514 Tacony St., Phila., are offering as premiums to users of their packing, many valuable tools and novelties free; their catalogue explains. Write for it.

If you are interested in mechanical rubber goods and packings and also use tobacco, here is your chance to kill two birds with one stone. You may learn something about good packings and get a rubber tobacco pouch, both free. Write to Sayen & Schultz, 13th and Commerce Sts., Philadelphia; give name, address and where employed as engineer.

The season is at hand when the word fan possesses a magic sound. Many work rooms, especially engine rooms, become so hot in summer as to be almost unendurable, yet human beings are expected to put up with it when a few dollars expended for a fan would lower the temperature many degrees. Joseph Carr, 132 North Seventh St., Phila., is the manufacturer of a very excellent ventilating fan which is easily installed and very moderate in price. Circulars will be mailed and prices quoted upon request.

There is no part of the steam plant so little and yet so important as the valves. The Wm. Powell Co., of Cincinnati, Ohio, have appreciated this fact and have embodied in their valves the latest Twentieth Century thought and experience. Their "White Star" valves are models of simplicity and unequaled for durability. The disks are made from a new alloy which is very durable and is guaranteed to withstand a temperature of 2000 degrees. Write for catalogue.

Larkin's Metallic Packing is known wherever an engine has found its way. It is composed of the finest metals, which will withstand friction and wear without being hard enough to cut, and graphite. It has been used on steam pressures as high as 310 pounds, water pressures as high as 2500 pounds, and on pumps, air compressors, ice machines, elevator rods and expansion joints. The Pennsylvania Electrical and Railway Supply Co., of Pittsburg, are the general sales agents. They send this packing on 60 days' trial to anyone wishing to try it.

The Advance Packing and Supply Co., of Chicago, Ill., manufacture "Advance" packings in all sizes and shapes for different purposes. They also carry in stock a complete line of the following well-known packings: Peerless, Eureka, Garlock's, Daniel's P. P. P., Jenkins' 96 Sheet, etc. An interesting catalogue will be sent to anyone mentioning "The Practical Engineer."

Mr. L. J. Lomasney, formerly of New York City, now Vice-President and General Manager of Sales of The Republic Rubber Company, of Youngstown, Ohio, advises the opening of a branch store by the Republic Company at 116 Lake Street, Chicago. This store is one of the handsomest in the city.

Mr. Lomasney also advises the opening of a branch store at St. Louis, for distributing and applying tires. This branch is managed by Mr. Geo. M. Hoffman, who stands without a rival as to ability and strict honesty in dealings with his trade.

The Republic Rubber Company has, within a short time, come rapidly to the front in the manufacture of fine mechanical rubber goods. Their line is a varied one, including belting, hose, packings, molded goods of all kinds, solid vehicle tires, fire hose, and in fact almost anything that enters into the line of rubber goods.

Their factory is one of the finest that has ever been erected, complete in every detail, and equipped throughout with electrically driven machinery, each machine being controlled by an individual motor.

Their plant represents an investment of very close to half a million dollars, and their organization is thorough and complete. A bright future is particularly predicted for this Company, in view of the fact of their extremely modern factory, and complete organization, which is composed largely of young men who have grown up in the rubber business.

The Great BURNHAM Steam Pumps
WILL NOT SHORT STROKE
MANUFACUTRED BY THE
Union Steam Pump Co.
BATTLE CREEK, MICH.

"An Oily Tale" is the suggestive title of an interesting little booklet just issued by the A. W. Harris Oil Co., Providence, R. I., and which any engineer may secure by sending them his address and plant connected with.

It is a maxim of the Harris Oil Co. to suit the oil to the requirements which, as they say, is the secret of satisfactory and economical lubrication and any engineer, if not already using these oils, would do well to put himself in touch with the A. W. Harris Oil Co. and get his name on their mailing list.

The Homestead Valve Manufacturing Co., of Pittsburg, Pa., are leaders in the march of progress in valve making. The Homestead Valves, which were awarded the Diploma of Honorable Mention at the Paris Exposition in 1900, unsolicited, are unlike all others, for the reason that when the pressure passes through it, the seat is absolutely protected from wear. Their latest catalogue describes the Homestead self-locking straightway, three-way and four-way high-pressure balanced plug valves and the Homestead locking cocks. Send for it.

G. Frank Duemler, the Philadelphia representative of the Dearborn Drug and Chemical Works, with offices in the Bourse, is meeting with excellent success, having made many converts in Philadelphia and vicinity to the Dearborn method of treating boilers for the removal and prevention of scale.

The Practical Manufacturing Co., Richmond, Ind., manufacturers of the Practical Belt Stick, offer to send a free sample stick to any engineer or steam user upon request.

W. Clifford Smith, 140 North Sixth St., Philadelphia, has increased his facilities for the manufacture of Smith's clamps for stopping leaks in pipe joints and is now prepared to furnish any sizes desired at a moment's notice. Mr. Smith also manufactures grate bars and castings of every description.

The McLeod & Henry Co., Troy, N. Y., have a remarkable "Steel Mixture" which has high heat-resisting properties. It is formed in Fire-Box Blocks and Boiler Door Arches ready for use, and when in place, they make a wall the height of the fire all around the fire box. This wall remains smooth and solid indefinitely and saves money to the user.

The thermodynamic efficiency of an injector is 100 per cent. What better machine do you want than that? The Penberthy Injector Co., 344 Holden Avenue, Detroit, Mich., have sold 300,000 of their Automatic Restarting Injectors, which speaks very well for them.

The extensive improvements contemplated by the Phoenix Cement Company, Nazareth, Pa., have all been laid out by Dodge & Day, Modernizing and Contracting Engineers, Nicetown, Philadelphia, Pa., and it is thought the work will be started in the near future. Most of the buildings will be enlarged, electric transmission used throughout, and the entire plant thoroughly modernized in order to materially increase the output to keep pace with the growing demand for the Cement Company's product. This will necessitate the installation of considerable additional power equipment, as well as a 200 kilowatt generator, tandem compound engine for generator, one 50 and one 75 H. P. motor, as well as a number of smaller motors; charging cars, turn-table, coal and ashes conveyor, underfeed stokers, steam locomotive for hauling cars to and from the quarries; electric hoist, electric air compressor, blower and exhauster, air-cooling conveyor, belt conveyors, elevators, automatic weighing machine, extension of track system, etc.

WANTED. Local agents in all parts of the Country to sell WILLIAMS STEAM SPECIALTIES. All familiar and connected with power plants can largely increase their income. Many are building homes by selling our goods. Engineers and others are doubling their incomes in their spare time. **Our goods reduce fuel bills,** and appeal strongly to those who pay the bills, and repeated orders is **the rule. Write us** at once for full information.

THE WILLIAMS GAUGE CO.
543 Fourth Avenue - - - Pittsburg, Penna.

IF ENGINEERS will send $1.00 to the address below they will receive two blue prints, with tables and instructions, showing how to set valves and eccentrics on Corliss engines, simple and compound, with one and two eccentrics.
JOHN T. LINDSTROM,
214 and 216 S. 3d St., Allentown, Pa.

Wanted ENGINEERS... AND SALESMAN
To handle France "Steam Stopper" brands of Metallic and Fibrous Packing as a side line. Good inducements to right party. Address
FRANCE PACKING COMPANY,
TACONY, PHILA., PA.

EXPERIENCE teaches that the BURT EXHAUST HEAD is the only head for satisfactory service.

"The two Burt Exhaust Heads which we are using at our mines are giving good satisfaction. This is evident from the fact that we used one a year or more before we purchased the the other" — Carnegie (Pa.,) Coal Co.

Send your order, with size of pipe, to-day; if dissatisfied, return.

THE BURT MFG. CO.
Largest Manufacturers of Oil Filters in the world.
204 Main St., Akron, Ohio, U. S. A.
Also supplied by Engine Builders, Dealers, and Power Contractors.
FAIRBANKS CO.
Sole Agents for Philadelphia.

FLAKE GRAPHITE HAS ALWAYS CURED FRICTION TROUBLES

Write for a copy of Dixon's newest Publication

"Graphite as a lubricant"

and learn the possibilities of Graphite Lubrication.

JOSEPH DIXON CRUCIBLE CO.
Jersey City, N. J.

Cochrane Receiver Separators

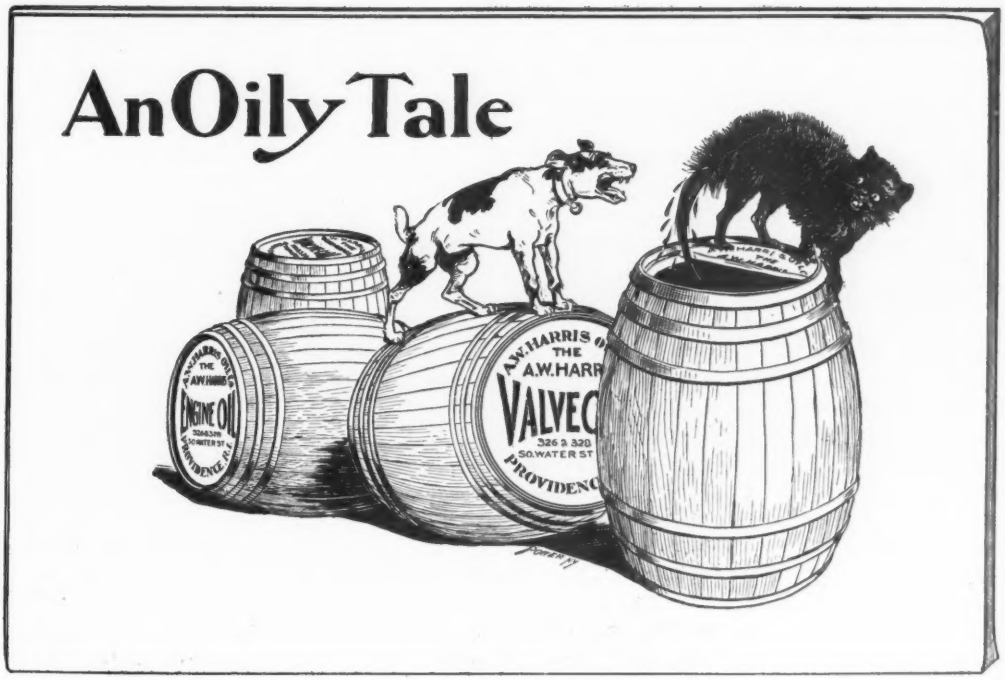
The Cochrane Receiver Separators have the same ability to take water out of steam as our Cochrane Steam Separators, since they embody the same principles of design; but, in addition to this, these Cochrane Receiver Separators are provided with extra large wells or receivers for taking care of any flush of water that may be suddenly carried over with the steam, and for providing a resevoir for storing a supply of steam close to the engine, upon which the engine may draw when a momentary demand is made for extra steam.

Pulsations and hammering in the steam pipes are also prevented by the Cochrane Receiver Separators, since the steam stored in the Separator acts as a cushion and maintains the maximum boiler pressure at the end of long lines of piping. For further information, prices, etc., send for our **Catalogue 16-S.**

HARRISON SAFETY BOILER WORKS
3144 N. 17th Street
PHILADELPHIA, PA.

Manufacturers of Cochrane Feed Water Heaters, Cochrane Steam and Oil Separators and the Sorge-Cochrane Systems.

Of course you want a copy of



This is our new book which we are sending free to our friends. It serves two purposes:—First, it is hoped that it will interest you and perhaps induce one of those laughs that will put flesh on your bones; second, it will tell you in an entertaining fashion of the sure rewards that come through the use of

Harris Valve Oil for internal lubrication and Harris Engine Oil for external lubrication.

The book will be ready early in April. If you want to make sure of getting one, tear off coupon at this line and mail to-night.

A. W. HARRIS OIL COMPANY,

323 South Water Street, PROVIDENCE, R. I., U. S. A.

Send me a Copy of "An Oily Tale."

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*Where employed*_____

*Address*_____

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LUBRICATES EVERYTHING

Adapted to all kinds of machinery

Cost of using oil

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Remember, a sample can of Albany Grease with an Albany Grease Cup free of charge or expense for testing.

THIS TRADE MARK ON EVERY PACKAGE. Sold by Engineers and Mill Supply Dealers the World over.

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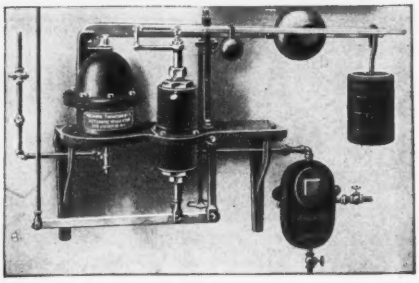

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Indicators, Reducing Wheels, Planimeters, etc.

The Soot Ejector and Injector Blower, Boiler Tube Cleaners. Shaking, Dumping and Stationary Grate Bars.

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WHY

Homestead Valves

are demanded in all four quarters of the globe

We will impart the secret to you. They are higher priced and very much better than the ordinary kind for all *HARD-TO-FILL* places.

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Homestead Valve Mfg. Co.

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Works at Homestead, Pa.

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PACKING, IT WILL PAY TO INVESTIGATE

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DURABLE, SELF LUBRICATING, RELIABLE AND EVERLASTING

The only Metallic Packing thoroughly incorporated with Graphite.

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Western Agents for Just Mechanical Purifier.

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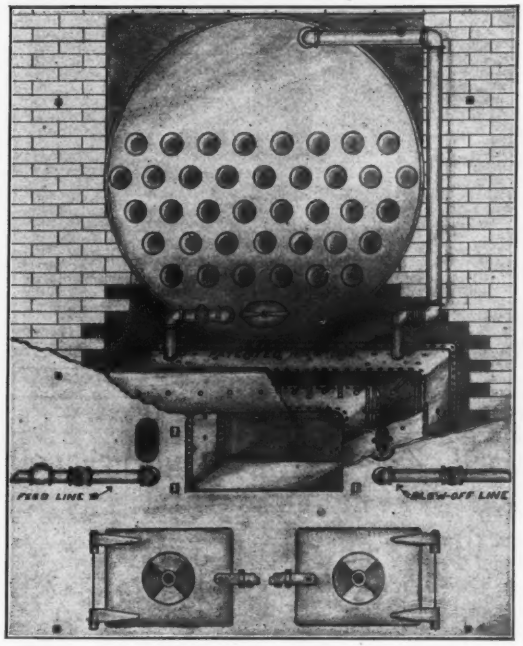

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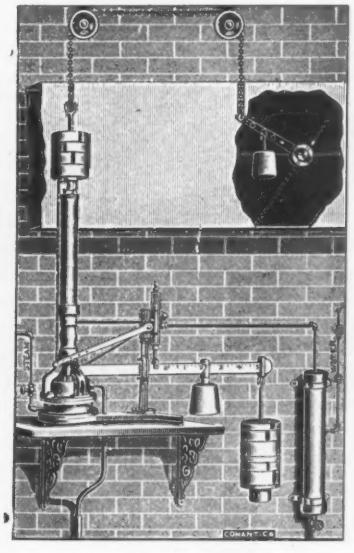

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The Tornado Boiler Tube Cleaner

Requires **LESS** steam than any other cleaner.
Will positively clean **BETTER** than scraper or brush.
Will clean ANY length tube.
In operation is **EQUALLY** balanced, insuring **NO** back pressure against operator.
Is the **LIGHTEST** and **EASIEST** cleaner to handle.
Has **NO** working parts.
Its force is tremendous.

Manufactured by

Paul B. Huyette

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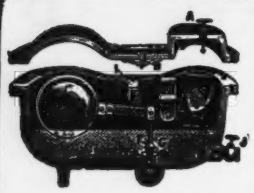

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Always have a Water Seal over the valve and never blow steam; neither do they back up water

REDUCING VALVES
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HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
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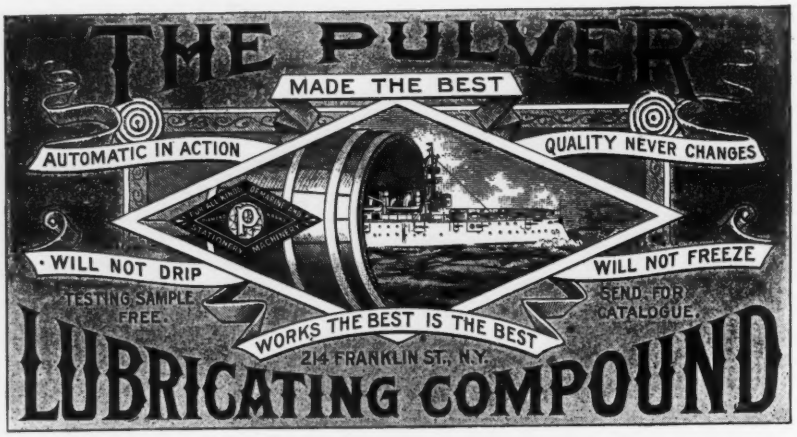

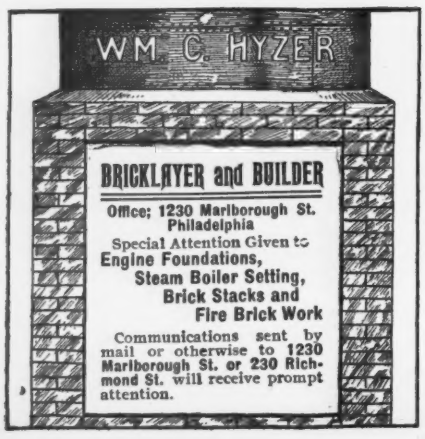
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Back Pressure and Relief Valves that never fail.

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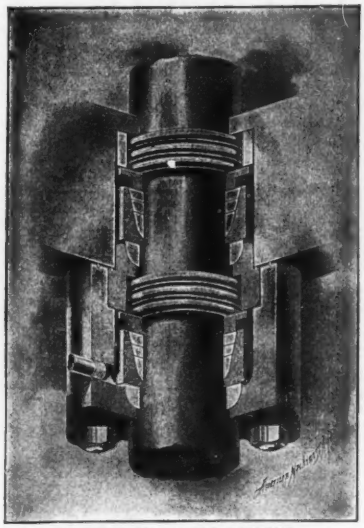

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We can present convincing proof of their worth.

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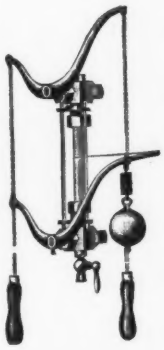

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Closes instantly when glass breaks, without loss of one drop of water or steam excepting that contained in glass.
Principle is gravitation, which cannot fail.
Order and specify The "Cunningham" Water Gauge and be secure from annoyance, damage and danger.

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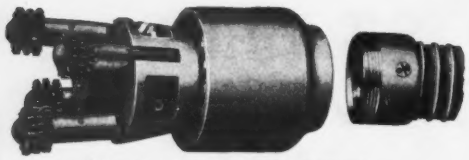
Read Our Guarantee

They will cause no back pressure on the engine or allow condensation to get on to roofs or walls. Send us the size of your exhaust pipe and we will quote a delivered price :--subject to return if not as we represent.

STERLING PIPE AND BLOWER CO.
HARTFORD, CONN.



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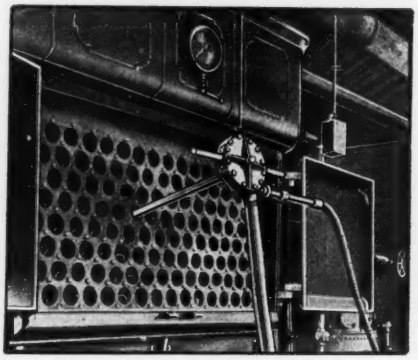
THE WEINLAND

The King Of Turbine Cleaners

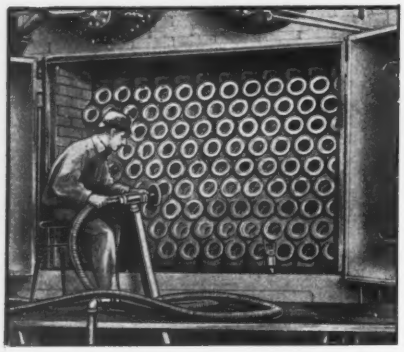
We will fully protect customers in case of suits of Competitors, threats of which prove they cannot meet **Merit with Merit**, in fair and honorable manner.

Our Direct Motor Cleaner

Solves the problem of greatest economy in BOILER CLEANING. Motor works outside of tubes. No friction or wear there. Develops ample power for severest work. Cutter head and all working parts remarkably strong, reducing item of EXTRA PARTS TO THE MEREST TRIFLE. Will do as much work in given time as five ordinary cleaners, and easily outlasts twice that number.



Direct Motor Cleaner, Patent Applied For.



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All Machines Sent on Trial.

The Lagonda Reseating Machine

for cleaning faces, nuts and caps of Boiler Headers. Works quickly and thoroughly and SAVES A LOT OF TROUBLE, as refitting of caps is unnecessary after using this machine. Write us about your Boiler Cleaning troubles. We're experts. Had 20 years' experience and "know how."

The Lagonda Mfg. Co. Springfield, Ohio.

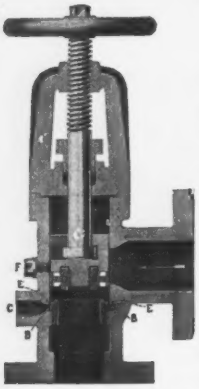
New York Office: 123 Liberty Street.

Boiler Tube Cleaners Blow-off Valves

The Liberty Turbine Boiler Tube Cleaner

will clean tubes more thouroughly, at less cost, and in less time than can be done by other means.

This we guarantee.



We also make the **Niagara Turbine Tube Cleaner.** We have suit for infringement of patents against a user of the Weinland machine, and will sue all other infringers

The Faber Blow-off Valve

washes its face every time it is opened and closed.

A connection at C admits steam at boiler pressure to chamber B, whence it escapes through slot E all around the seat, and sweeps both seat and disk free from sediment just before closing. It will last as long as a steam valve without leaking.

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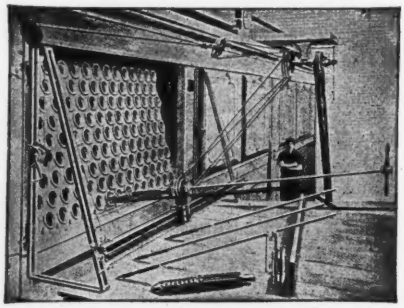
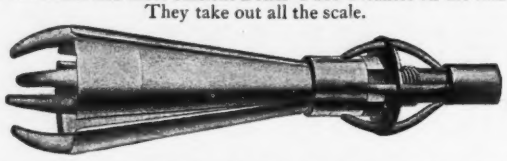


The Union Boiler Tube Cleaners

POWER OR IMPULSE

Are the oldest and most efficient Boiler Tube Cleaners on the market. They take out all the scale.



The Gem Flue Scraper

does the same for Smoke Flue Boilers

We also make **Gem Oilers,** Patent or Plain, **Torches and Heavy Brazed Steel Oilers, Flexible Shafting, Loose Pulley Lubricator.**

Write for Catalogue and Prices.

Gem Manufacturing Co.

Spruce near 33d Street - Pittsburg, Pa.

THE ENEMY IS ROUTED

AND UNCEREMONIOUSLY OUSTED FROM YOUR BOILERS WHEN YOU HAVE A **TORPEDO**

POSITIVE VISIBLE PROOF.

This mound of scale weighing 2280 lbs. and consisting of seven big wheel barrow loads, was removed by a "Torpedo" from two 50-h.p. boilers, at the plant of the Grafton Stone Co., Elyria, Ohio. The amount of scale removed caused the utmost surprise to the engineer and the firm. No other device on earth can so quickly and thoroughly clean a fire tube boiler and without causing the tubes to leak in the slightest.

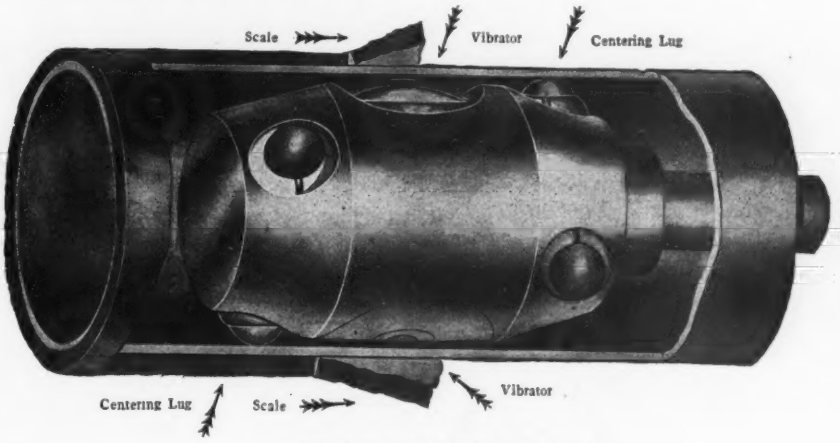
ACTUAL PHOTO. REPRODUCTIONS.

This is from Stratton & Hill, Millers, Flushing, Ohio. This is what they write us:

"We are sending you under separate cover two photos, illustrating the success we have had with the "Torpedo." When the machine started through the tubes the scale fairly rained to the bottom of the boiler. Our engineer said after we put it through four or five flues—'Stratton that is the best thing you ever bought.' And it certainly has proved a success. We removed and weighed 765 lbs. scale from 53 tubes. Tubes 12 ft. 6 in. long, 3 in. diameter."

After you have laid awake nights and tried every conceivable to scheme for getting that detestable Scale off those boilers of yours, it does your heart good to see the coal eating crust jump when the TORPEDO gets after it. There's a pile of satisfaction about it because you can actually see the whole operation. Everybody is glad; the engineer, the fireman, and the man who pays the bills—all except the coal dealers.

SENT ON FREE TRIAL



YOU BE THE JUDGE

THE "TORPEDO"

"WORTH ITS WEIGHT IN GOLD."

is built upon a correct mechanical principle, perfect in design and operation. Will not cause leaky tubes and **GUARANTEED TO SAVE ITS COST WITHIN AT LEAST SIX MONTHS.** Write to-day naming size of tubes and we will send you one on approval.

The General Specialty Co., 75 Carroll Street, Buffalo, N.Y., U.S.A.

DID YOU SAY YOU HAD SCALE IN YOUR BOILER =?=

IF YOU HAVE, WHY NOT LET US TAKE IT OUT =?=

WE ARE THE SOLE MANUFACTURERS OF RED STAR BOILER COMPOUND, WHICH WE STRICTLY GUARANTEE WILL REMOVE OLD SCALE AND PREVENT THE FORMATION OF NEW, WITHOUT INJURY TO EITHER BOILER OR FITTINGS. OUR 96 PAGE BOOKLET CONTAINS MUCH INFORMATION IN REGARD TO THIS MATTER AND WILL BE SENT FREE TO ANY ENGINEER MENTIONING THIS PAPER.

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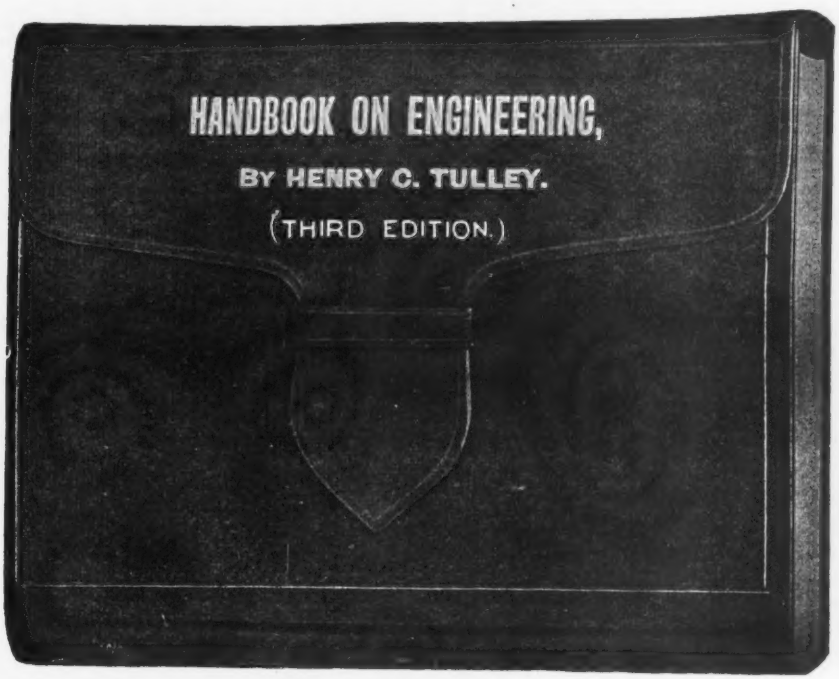

THREE-QUARTERS SIZE.

It Teaches the art of erecting engines and setting them in line.

The setting of valves on single and double eccentric long range Corliss engines.

How to set valves on different types of steam pumps. Care of injectors and inspirators. Rules and methods for figuring heating surface, tensile strength of boilers and tanks, measuring power, etc.

Direct current for lighting, alternating currents for arc lighting, two and three phase currents fully illustrated and explained with about fifty illustrations and seventy-five pages.

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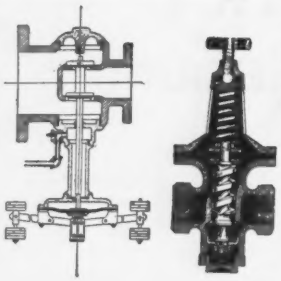

Manufacturers' Agents for Philadelphia, representing the

Watts Regulator Co.

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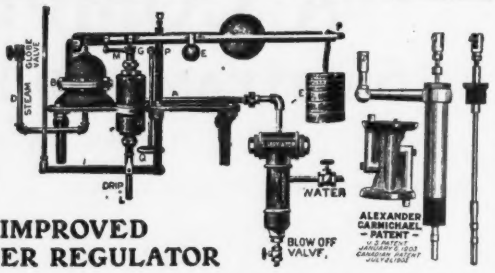

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Heating, Drying and Ventilating Systems. Forced and Induced Mechanical Draft.

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FIRST—A Steam Separator that will separate the water from the steam before it leaves the boiler. The Separator here shown is placed inside of the boiler directly under the steam outlet to the engine, and is guaranteed to reduce the moisture to three-quarters of one per cent.

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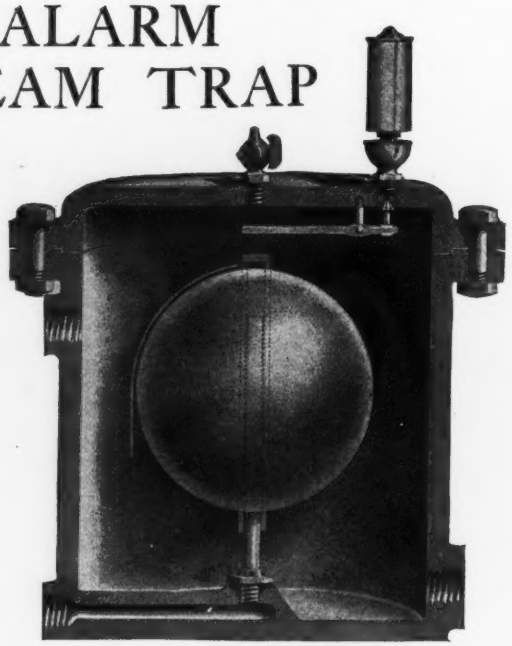

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$200 in Gold

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The third nearest will receive

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In case of a tie the money will be evenly divided between the tied parties.

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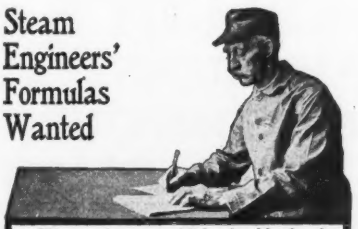

We are about to publish a booklet for the use of engineers and power users. To make it as complete and practical as possible, we want every engineer or power user who has a tested recipe—not mathematical problem—relating to boiler or engine room practice, to send it to us, no matter how simple or old it may be. With the formula send this advertisement, your name and the address of the concern you work for.

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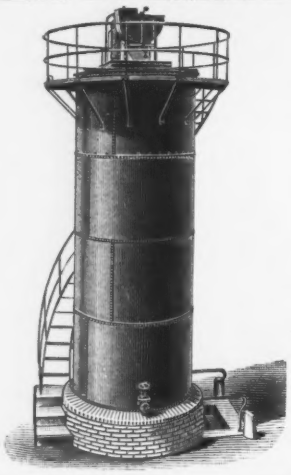

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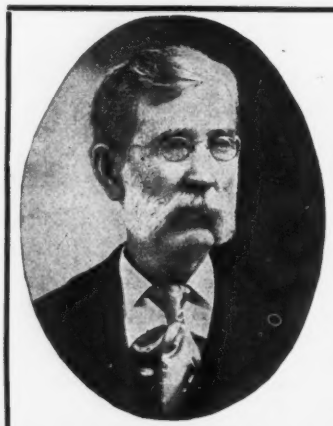

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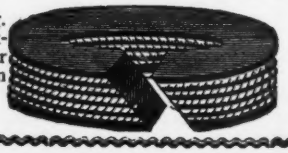

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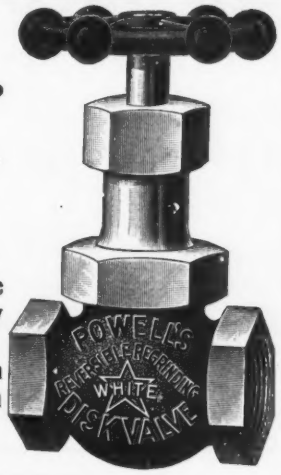

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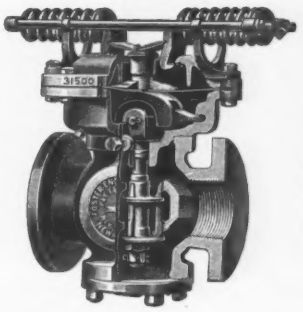

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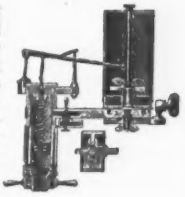

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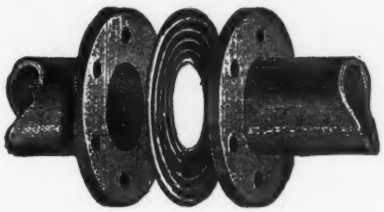

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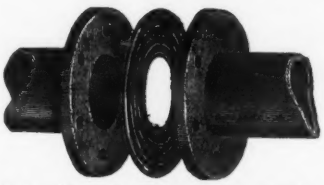

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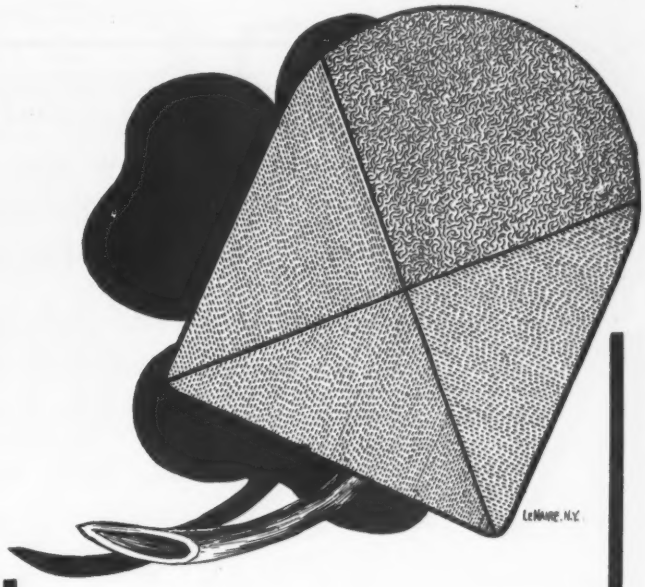

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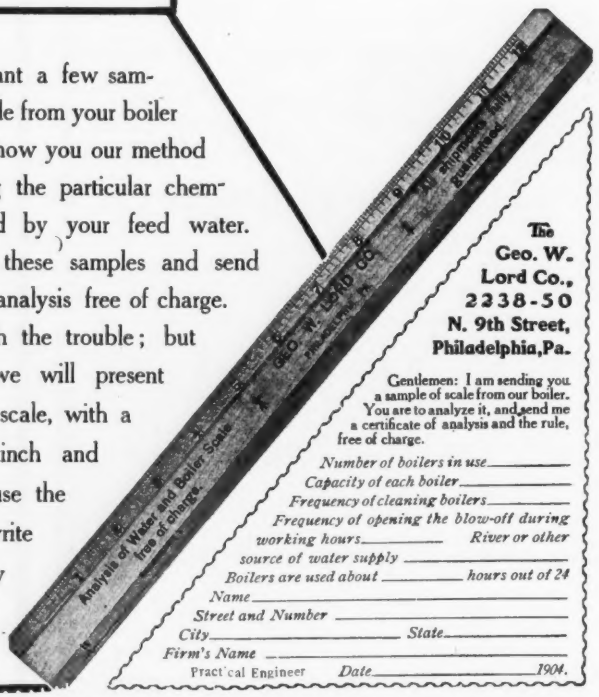

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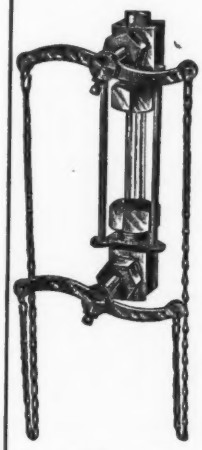

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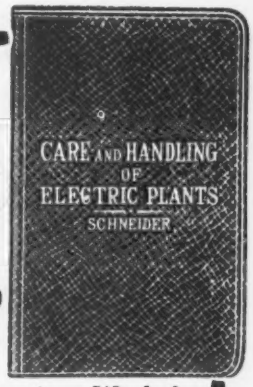

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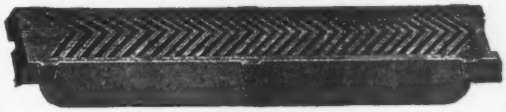

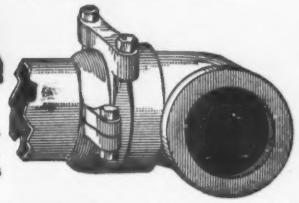

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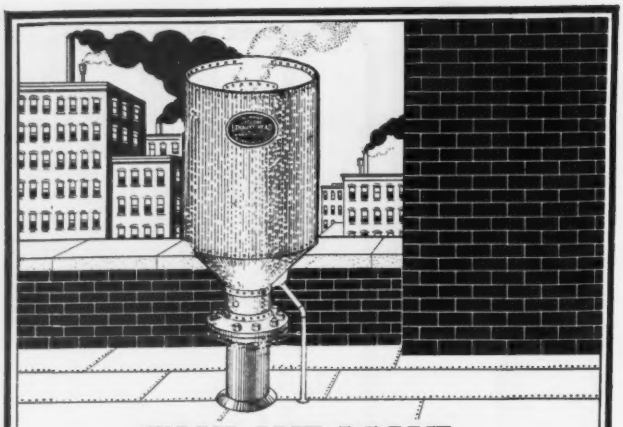

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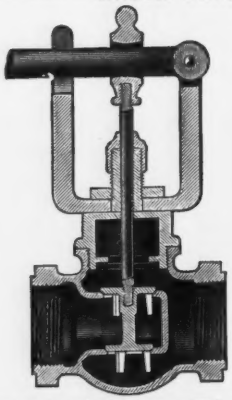

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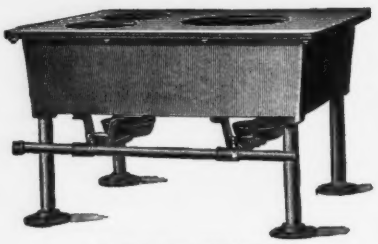
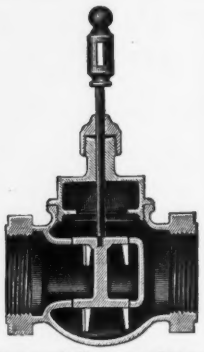


GAS GLUE HEATER

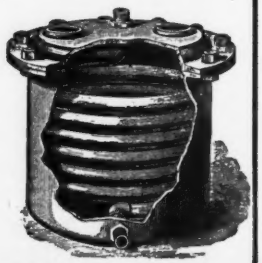


Balanced Governor Valve

"SIDELUG" STEAM TRAP
For Pressures 70 to 150 Lbs.

High Pressure Vertical Tube Radiator

HYDRAULIC VALVE



FEED WATER HEATER

Distributing Agents

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YOU WON'T BE STUCK

IF YOU USE THE

Practical Belt Stick

To make belts pull and not slip does not injure belt but prolongs life worth a hundred times its cost. Don't wait but try it now. Write to-day for

A FREE SAMPLE STICK

Practical Manufacturing Co.

RICHMOND. INDIANNA.

Lamprey Protective Arch Plates

Protect your boiler fronts from burning out, preserve the brick work, save fuel, and increase the efficiency of your boiler, by giving additional heating surface. Save their cost in repairs alone.

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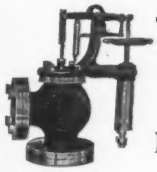
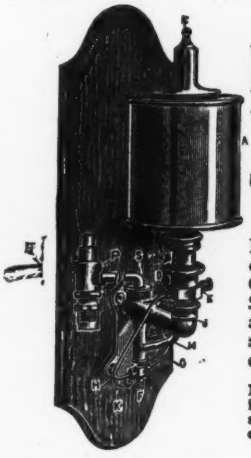


THE CARR PUMP GOVERNOR

Send for catalogue and learn how you can save hundreds of dollars in coal bill by using the Carr Feed Pump Governor. 30 days trial.

E. M. Carr,

New Castle, Ind., U. S. A.



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Kellam Damper Regulators

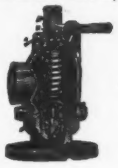
The Simplest and Closest Damper Regulator

Manufactured by

J. E. Lonergan & Co.

211 RACE ST., PHILA., PA.

Brass Founders and Finishers and Makers of Pop Safety Valves, Water Relief Valves, Oil Cups and Lubricators, Steam Pressure Regulators and other safety steam appliances.



Old Kellam Regulators Repaired. Correspondence Solicited. Mention this paper if your inquiry is prompted by the sight of this advertisement. Catalogue D free on application.

ESTABLISHED 1871.

J. & G. RICH

General Machinists

ENGINE BUILDERS

AND DEALERS IN MACHINERY.

Especial Attention Given to Repairing and Erecting Steam Engines, Pumps and Other Machinery, Shafting, Hangers, Pulleys, Etc., Etc.

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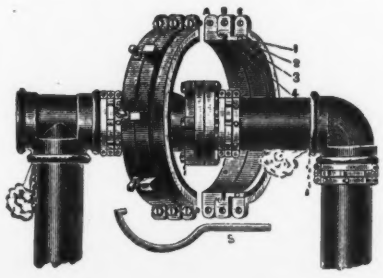
EVERY CLIMAX STEAM JOINT CLAMP



is guaranteed to STOP THE LEAK. Made of BRASS for all sizes of pipe, and can be attached in a few minutes without shutting down the plant. Thousands in use, and adopted by the largest steam users as a permanent repair.

JAMES McCREA & CO.

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67 W. Washington Street, CHICAGO

Boilers scaled?
Boilers pitting?
Boilers corroding?
Boilers prime?
Boilers foam?
Steam Joints leak?
Cylinders hard to lubricate?
Too much moisture in steam?

The Answer — USE DEARBORN

"DEARBORN" stands for the Scientific Water Treatment, made to suit the analysis of each water.

"DEARBORN" stands for Treatment that does just what you want it to do.

"DEARBORN" stands for the Treatment that is so thoroughly condensed that you are neither buying nor paying freight on water.

"DEARBORN" stands for the Treatment that absolutely cannot be injurious to heaters, feed-pump, piping, boilers or steam connections.

The nature of practically all waters necessitates your using something if you will find out what all others have done, then investigate what this Company has done, you will without question, adopt DEARBORN WATER TREATMENT in your boilers as a permanent solution of the problem.

Dearborn Drug and Chemical Works

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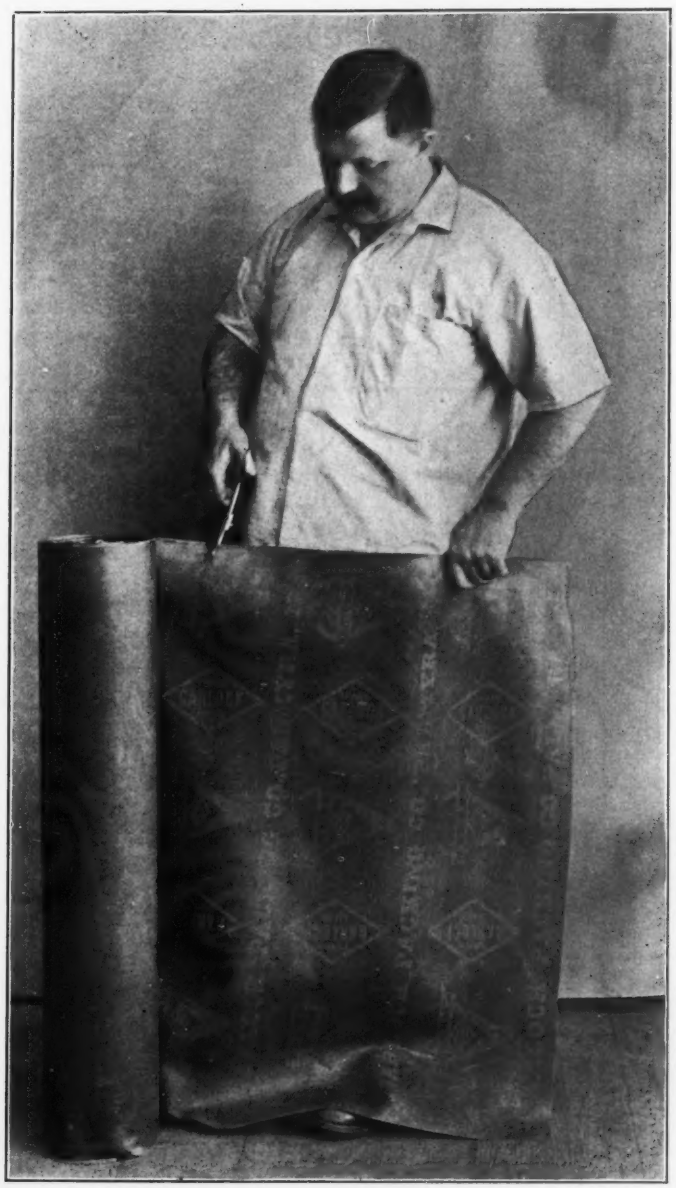

153

is the Garlock Oil Proof Sheet.

It is Oil Proof.

It is Non-vulcanizing.

It is almost everlasting.

It is covered by the Garlock guarantee.

It is a whole lot of other things.

But Best of All.

It is made of the same special patented compound as our Extra 333 Ring, famous among all engineers for pressure resisting and non-vulcanizing qualities, and ability to do the best work under hardest conditions.

It Is A Winner.

WE GUARANTEE ALL GARLOCK PACKINGS. WRITE FOR CATALOGUE.

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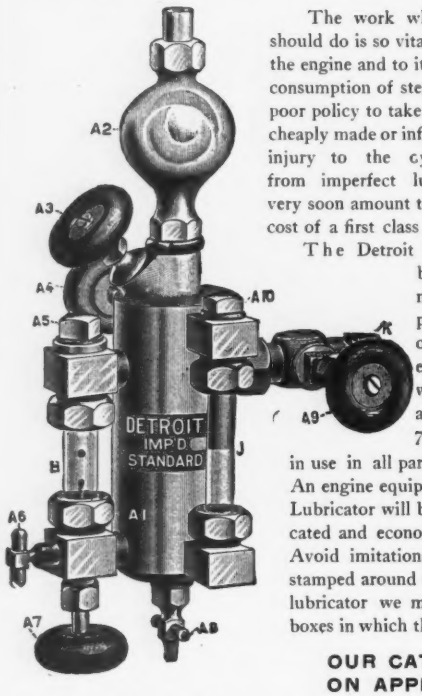
The Importance of a Reliable Lubricator



The work which a lubricator should do is so vital to the welfare of the engine and to its efficiency in the consumption of steam that it is very poor policy to take any chances with cheaply made or inferior goods. The injury to the cylinders, resulting from imperfect lubrication, would very soon amount to several times the cost of a first class lubricator.

The Detroit Lubricators have been used by fully nine-tenths of the prominent builders of American steam engines for upwards of 25 years, and there are over 700000 of steam in use in all parts of the world. An engine equipped with a Detroit Lubricator will be perfectly lubricated and economically operated. Avoid imitations. Our name is stamped around the body of every lubricator we make, and on the boxes in which they are packed.

OUR CATALOGUE ON APPLICATION

Detroit Lubricator Company, DETROIT Mich.

KEEPS BELTS FROM SLIPPING FOR LEAST COST, AND NO TROUBLE

THE ADDRESS LABEL on 12 pound Box IS VALUABLE

CUT OUT THIS COUPON

STEPHENSON MFG. CO.
ALBANY, NEW YORK

Please send me your PREMIUM List.

My name is_____

Occupation_____

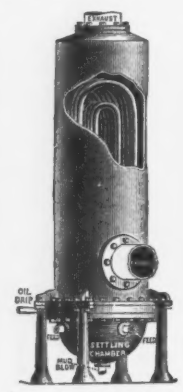
Street address_____

Post Office_____

Employed by_____

P. E

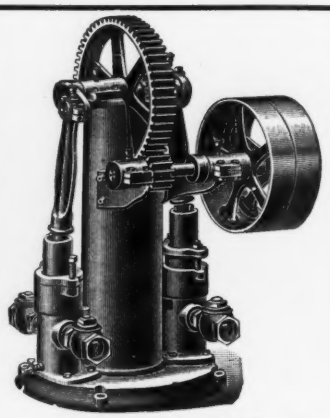
The Practical Engineer's Favorites



Improved to date

Improved to Date

Improved to date

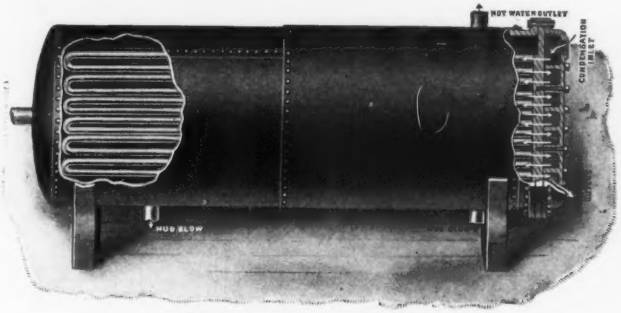


Improved to date

All Practical Engineers like our specialties, (FEED WATER HEATERS; EXHAUST HEADS; SEPARATORS and BELT PUMPS) because they are IMPROVED TO DATE. Because they have so many unusually good points about them. Write us, we will tell you what they are. Remember we can't get hold of your name unless you write us first.

FRANK L. PATTERSON & CO.

24 CORTLANDT STREET MANUFACTURERS NEW YORK



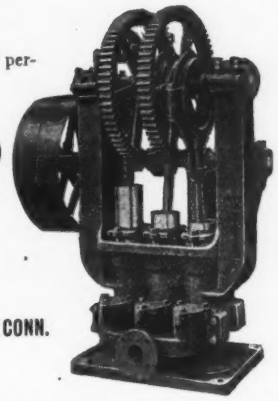
THE GLEANER TRADE MARK

The **Gleaner** represents the acme of perfection in feed water heating.

THE

Davis Triplex Power Pump

is a perfect type of the vertical triplex belt driven pump.



MANUFACTURERS OF

The "Berryman" Feed-Water Heater and Purifier.

I. B. DAVIS & SON, HARTFORD, CONN.

WRITE FOR CATALOGUE, ETC., TO

THOS. McADOO, 125 N. 4th St., Philadelphia

THE **OTIS** Tabular Feed

WATER HEATER, OIL SEPARATOR and PURIFIER

with Seamless Brass Tubes

Guaranteed

To heat the feed water to the boiling point (210 or 212 degrees) with the exhaust steam without causing any back pressure, **also to extract the oil from the exhaust,** so that the exhaust steam after being passed through the heater can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the additional expense of an eliminator.

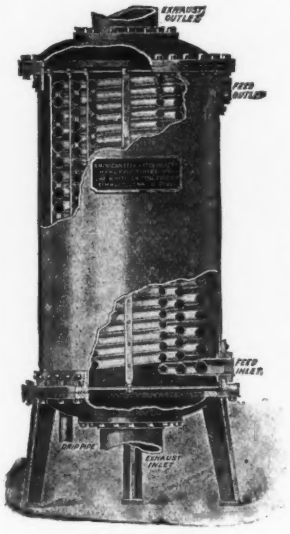
A Liberal Offer

If this heater fails to give satisfaction in every respect, we pay freight, cartage, etc., both ways.

The Stewart Heater Co.

11 Norfolk Avenue, Buffalo, N. Y., U. S. A.

THE AMERICAN STANDARD COPPER COIL FEED WATER HEATER



Simplicity!
Strength!
Economy!
A Money Saver!

It gives so little trouble that one of our customers, who has used one for three years, had forgotten that he had it when we asked him the other day how it was doing. He called in the engineer, who said it hadn't been touched since it was put in and was still heating the water to 210 degrees.

That's the kind of a Heater you want.

Write for Catalogue No. 100 P

The Whitlock Coil Pipe Co.

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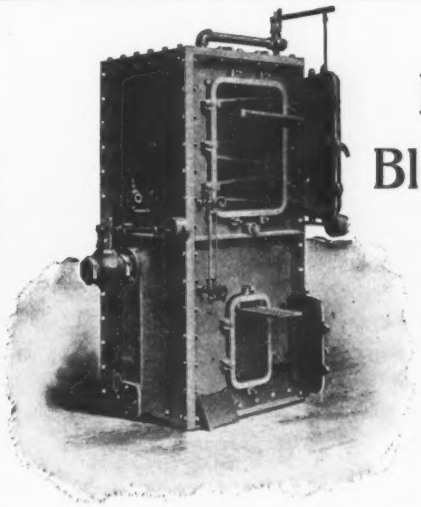


Don't Blow up.

"Thoroughfare" heaters are always in danger, because engineers some times forget, and opening a wrong valve has caused disastrous explosions.

WEBSTER FEED-WATER HEATERS AND PURIFIERS

use only just enough of the exhaust to heat the feed-water to the boiling-point. This is the cause of their safety, as well as their wonderful economy.

WRITE FOR BOOKLET.

Warren Webster & Co.

CAMDEN, NEW JERSEY.

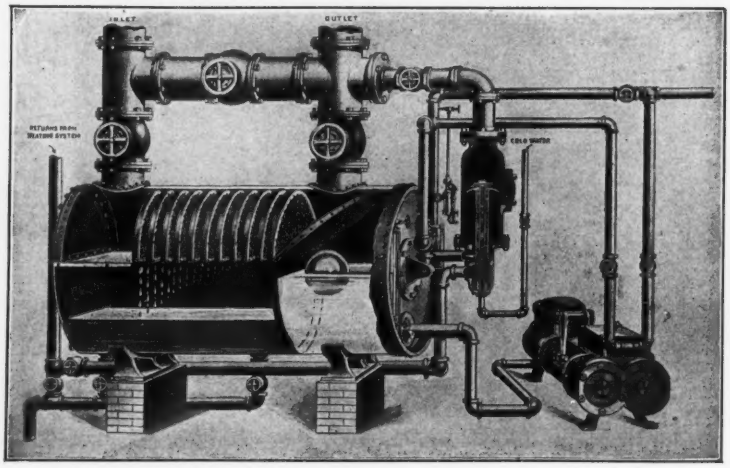
UTILITY STEAM SPECIALTIES

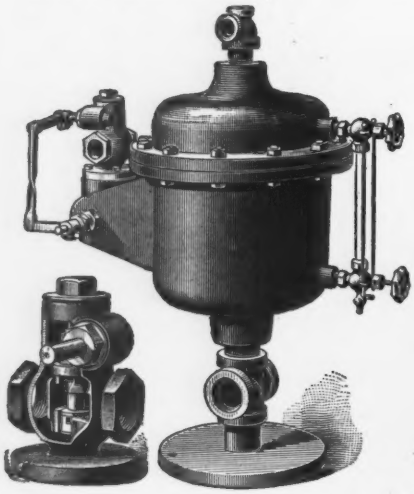
WE POINT TO WHAT
WE'VE DONE AS PROOF
THAT OIL CAN BE ENTIRELY
REMOVED FROM EXHAUST STEAM
AND THAT FEED WATER CAN BE HEATED
ABOUT TO THE TEMPERATURE OF THE EXHAUST BY

Our "Utility" Combination

We can always guarantee an elimination of 98 per cent. at the outlet point af separator. We average over 99 per cent and have in some cases left but 8-10,000 of 1 per cent. of oil in the water. You can't see this amount, you can't taste it; fresh well water frequently has more oil in it, and this water can be used for fifty years in boilers without showing a trace of oil deposit. The feed water heating feature is optional, but very efficient, free from back pressure and requires but little room and no floor space.

The "Utility" Combination serves as Exhaust Muffler, Oil Separator, Return Tank, Pump Governor and Feed Water Heater. It costs only about as much as a Feed Water Heater.





"Utility" Pump Governor

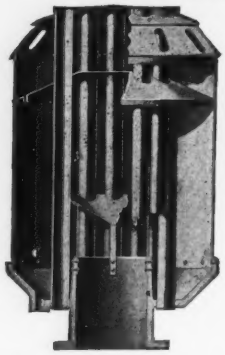
The best Pump Governor on the market. Why? Because our valve will not leak or stick; we guarantee it to absolutely govern the pump and remain tight for five years. Compare the construction of our valve with any other on the market. By adopting the "Utility" you can save coal and get a higher temperature from your heating or drying systems. Send for catalogue and list of users.

A New Application

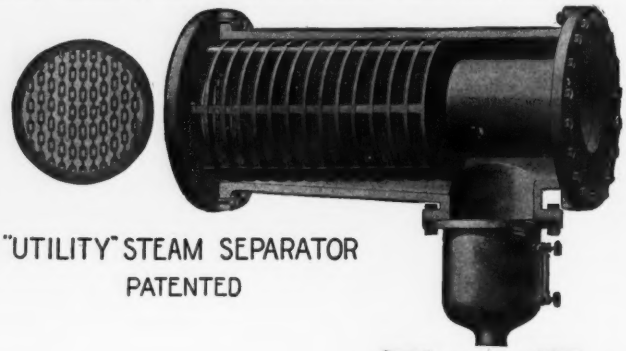
of the chain baffle plate principle which has proven so successful in the oil eliminator may be found in our

Steam Separator

and the efficiency of it is very high. Absolutely dry steam, absolutely no back pressure. What more could you ask?



UTILITY EXHAUST HEAD
PATENTED



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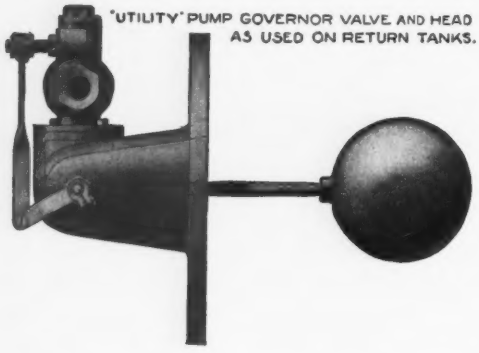
PATENTED

Another Water Saver

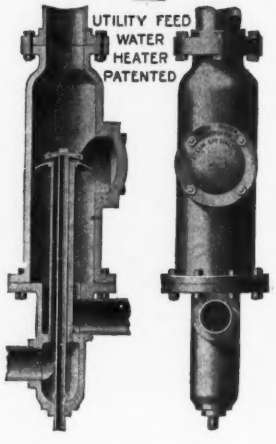
is our new Exhaust Head. Notice the great radiating surface that is given by the CIRCULATING AIR TUBES. These act as condensers, and they lessen instead of causing back pressure. Do you realize that a thousand gallons of water are wasted in a moderate sized plant which lacks an efficient exhaust head? It's so.



"UTILITY" PUMP GOVERNOR VALVE AND HEAD
AS USED ON RETURN TANKS.

WE
ALSO
CARRY
IN
STOCK

- Back Pressure Valves
- Blow-off Cocks
- Pressure Reducing Valves
- High and Low Pressure Boiler Feeders
- Reducing Pressure Reducing Valves
- Boston Boiler Thermostats
- Steam Traps
- Damper Regulators
- Feed Water Controllers
- "Utility" Beam Clamps



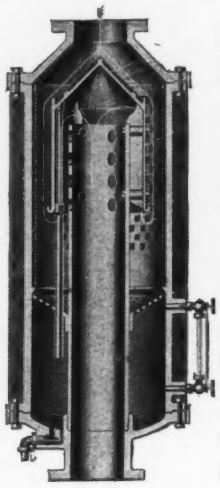
UTILITY FEED
WATER
HEATER
PATENTED

Standard Steam Specialty Co.

542 and 544 WEST BROADWAY
NEW YORK CITY

PHILADELPHIA OFFICE, ROOM 312, BOURSE BUILDING. BELL TELEPHONE, MARKET 44-95 A

Sweet's Separators



Our steam separators deliver steam containing less than one half of one per cent. of water.

Our oil separators remove 99 per cent. of the oil.

We can prove they do it and give good reasons why.

In addition they have size and are machines.

Made in all styles, also make Exhaust Heads and Steam Traps.

Direct Separator Co.

220 Marcellus Street

Syracuse : : New York

The Baum Separator

Horizontal Style for Live Steam or Oil Service.

For Live *and* Exhaust Steam
RESULTS GUARANTEED

For condensing systems use the BAUM VACUUM STYLE OIL EXTRACTOR.

Most satisfactory Separator on the market. Ask why.

The Baum Separator and Machine Company

Manheim, Pa., U. S. A.

Vacuum Style Oil Extractor.

Philadelphia Agents, AMERICAN SUPPLY COMPANY, 612 Betz Building

BERRYMAN

Feed Water Heaters and Purifiers

WATER TUBE AND STEAM TUBE

Cast Iron or Steel Shells. "U" Shaped Seamless Drawn Brass Tubes.

We Build Heaters for Every Purpose and Condition

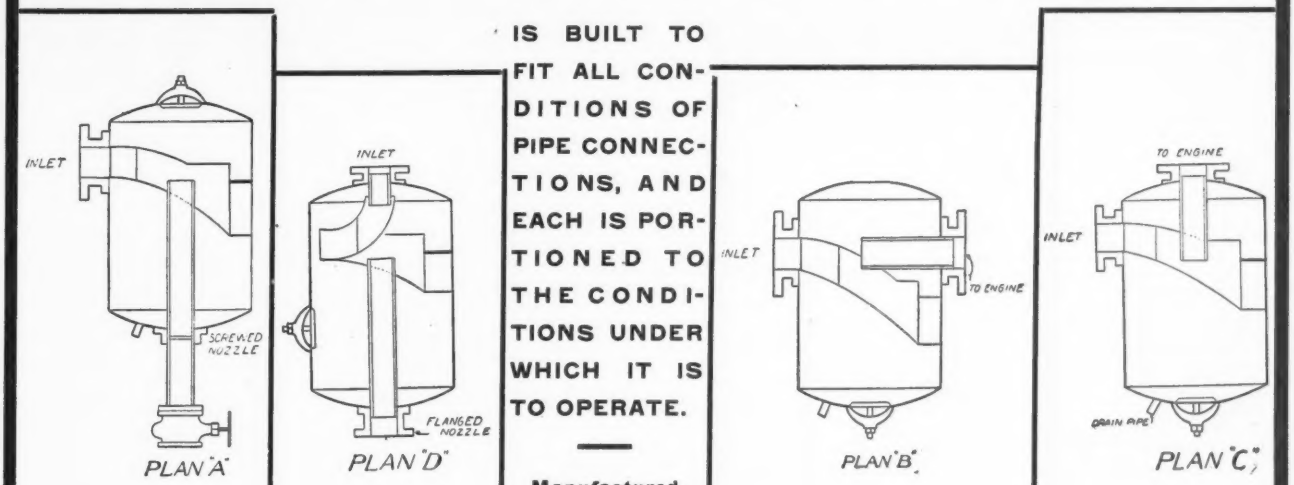
THE KELLEY PATENT

IMPROVED BERRYMAN WATER TUBE FEED WATER HEATER AND PURIFIER

Benj. F. Kelley & Son - Makers

91 Liberty Street, NEW YORK

The Simonds Steam Receiver and Separator



IS BUILT TO FIT ALL CONDITIONS OF PIPE CONNECTIONS, AND EACH IS PORTIONED TO THE CONDITIONS UNDER WHICH IT IS TO OPERATE.

Manufactured By

FRANK A. SIMONDS

421 HOUSEMAN BUILDING GRAND RAPIDS, MICH

FRANCE'S SPLIT CASE
AN ABSOLUTE STEAM STOPPER

"Steam Stopper"
BRAND
Packings

High Pressure Ring Packings
Sheet Rubber Packings
"Black Raven" Asbestos Packing
"France's Special" "France's Regular"
and High Prssure Diagonal Packings
"Reliance" Gum Core Packing
"Water Stopper" Flax Packing

Tuck's Square Piston Packing
Tucks Round Piston Packing
"Z" Packings. Spiral Packings
Pump Valves. Gaskets
Guage Glass. Washers, etc.

France's Metalic Piston and Valve Rod Packing a Specialty

Free. To introduce this packing we are offering, as premiums, every conceivable tool that an engineer, master mechanic, or superintendent could use, ranging from a monkey wrench to an indicator.

Get it of your dealer or send direct to

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(INCORPORATED)
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THE PRACTICAL
MANAGEMENT OF
Engines and Boilers
Compound and Multiple Cylinder Engines
and
Practical Management of Dynamos and Motors
BY WILLIAM BARNET LE VAN
Illustrated by 60 engravings. In one volume of 356 pages. Price by mail, $2.00.
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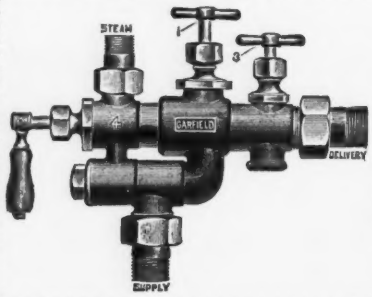


POWER PLANTS

Equipped with Garfield, Double Jet Injectors and Chicago Sight Feed Lubricators are as satisfactory to the owner as to the engineer.

Boilers steam easily and engines run smoothly.

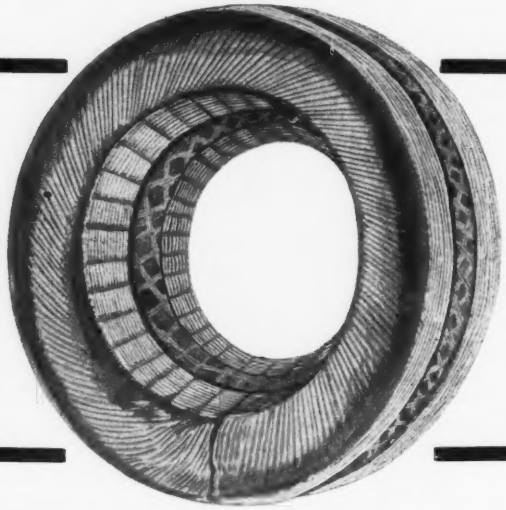
Send for catalogue and mention THE PRACTICAL ENGINEER.

The Ohio Injector Company
WADSWORTH, OHIO

TWICE A YEAR INSTEAD OF ONCE A WEEK

Here is a picture of an old ring of P. P. P. packing that has been in use for 26 weeks on a rod which had previously been repacked every week. The engineer was curious to see what the packing looked like after such long use, so he took it out, sent us half, and replaced the balance. The ring shows how, when properly packed, it will set itself to the grooves of a rod worn or scored by ordinary packings, and make a tight joint.

P P P



P P P

We have many letters telling of runs of one, two and even eight years on one packing. We will gladly send you photographic copies of the original letters upon request. Hundreds of engineers are taking life easy by using P. P. P., and there is no reason why you should not do the same. Write to-day for our interesting booklet on friction.

Quaker City Rubber Company
PHILADELPHIA AND CHICAGO

U.S. Automatic Injector

Many an engineer has made trouble for himself by specifying the wrong kind of injector.

If you want an injector that will do its work right all the time, and under all circumstances, specify

The U. S. Automatic Injector

Over 200,000 are in use and giving perfect satisfaction. After exhaustive tests in the government laboratory, this injector was adopted for use in the U. S. Navy.

Engineers should write for our "Red Book". It answers over 500 questions that confront engineers in their daily experience, and also tells all about

U. S. AUTOMATIC INJECTORS

AMERICAN INJECTOR CO., Detroit, Mich.

WE CAN SAVE YOU

MONEY

BY USING

"STEEL MIXTURE"

BOILER DOOR ARCHES AND FIRE BOX BLOCKS—

TONGUED AND GROOVED.

ENQUIRIES SOLICITED.

McLEOD & HENRY CO.

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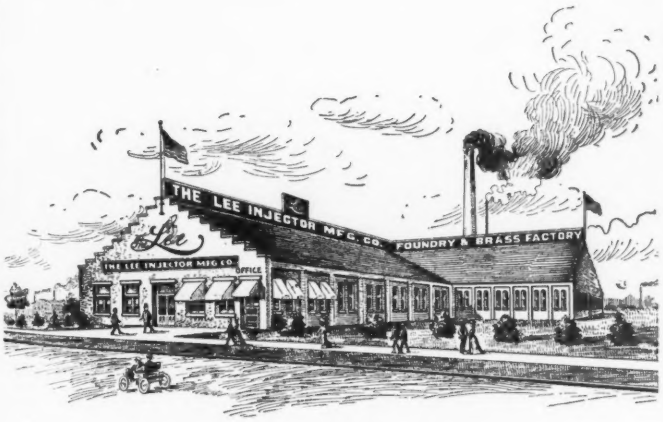

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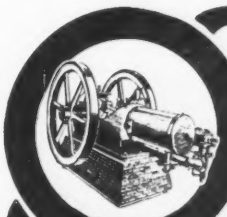

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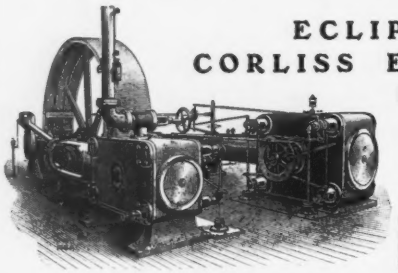

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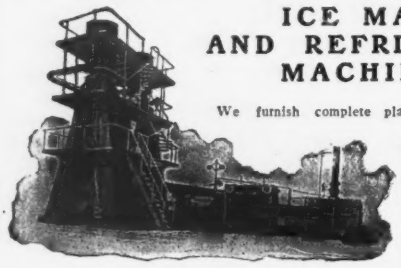

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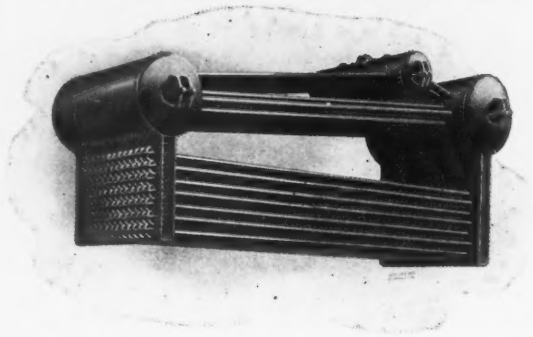

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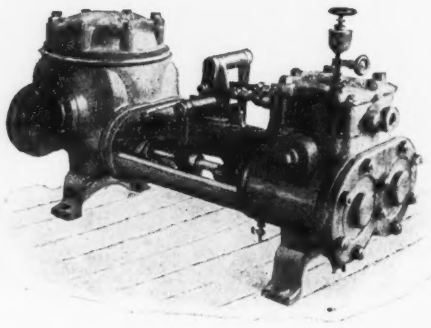

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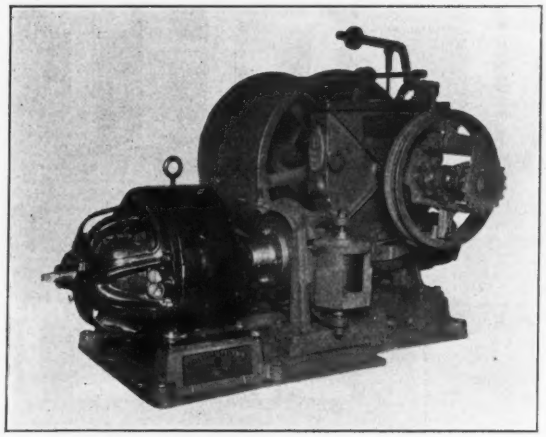

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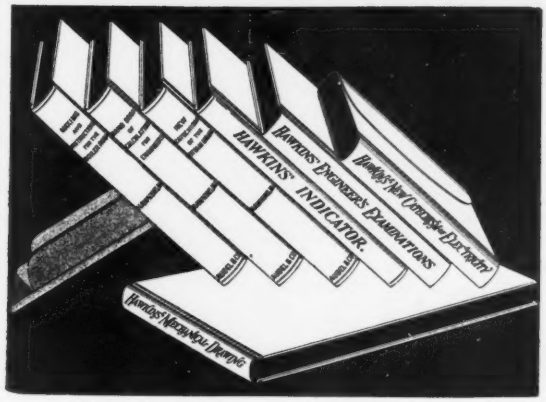

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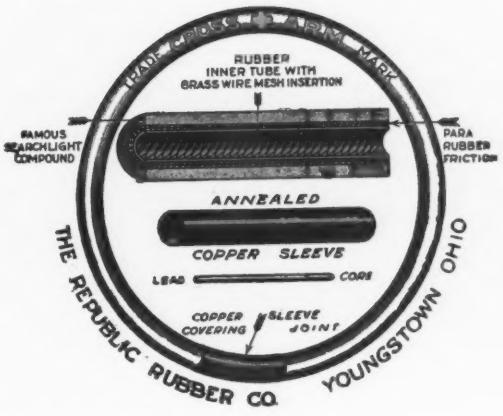

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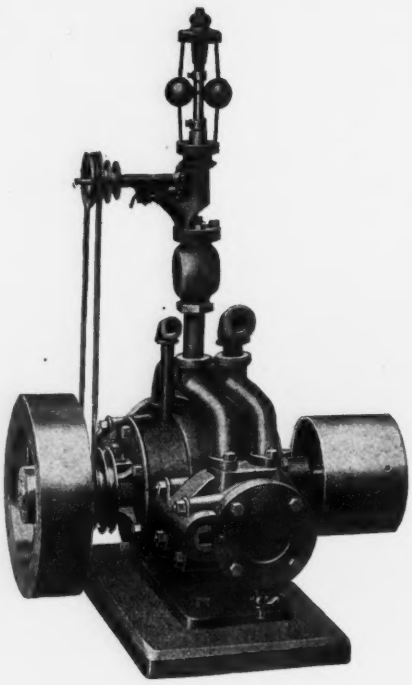

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